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NATURAL HISTORY MUSEUM
OF LOS ANGELES COUNTY

TERRA

Rancho La Brea: Death Trap and Treasure Trove

On Exhibit in Exposition Park

DEDICATION

This issue is dedicated to the memory of George C. Page (1901–2000), founder of the George C. Page Museum of La Brea Discoveries. His vision and philanthropy made the treasures of the tar pits available not only to the children of Los Angeles but to the people of the United States and to the international scientific community.

This issue of TERRA *is an expanded and updated reissue of Volume 31, Number 1, from the fall of 1992. Additional copies are available at the Page Museum as a separate book,* Rancho La Brea: Death Trap and Treasure Trove.

ACKNOWLEDGEMENTS:
The editors are grateful to Dr. John M. Harris for his contributions as guest editor. We also thank the following people for special assistance: Allen Burry, Dr. John Garth, Lynda Hess, Miles Kudo, Ed Lau, Bill Mason, Lisa McGinnis, Cathy McNassor, Robin A. Simpson, Sol Spritzer, Dr. J.D. Stewart, Dr. Tom Wright, and the staff at the Allan Hancock Foundation Library.

Chester Stock's *Rancho La Brea: A Record of Pleistocene Life in California* and Harris and Jefferson's *Rancho La Brea: Treasures of the Tar Pits* were published in the museum's *Science Series* and are available from the bookstores of the Natural History Museum and the Page Museum. Both contain bibliographies. In addition, an extensive bibliography on the geology, fossils, and artifacts of Rancho La Brea is available on request from the Rancho La Brea Department at the Page Museum.

COVER ILLUSTRATION:
Mural © 1988 Mark Hallett. Los Angeles Basin, 20,000 years ago. Gouache on linen, 48 by 100 inches.

"Pavilion of Wings" Butterfly House

South Lawn, April 28 through September 3, 2001

D. Meier

Experience a kaleidoscope of flying color in the museum's specially designed, outdoor butterfly pavilion on the south lawn. Stroll through a beautifully landscaped, enclosed area filled with hundreds of free-flying butterflies. Butterflies from across the United States can be seen and experienced in all their delicate beauty, including the giant swallowtail, monarch and American painted lady. Special ticketed admission applies.

This exhibit has been made possible by a generous grant from the Boeing Employee Community Fund of California. Additional support has been provided by House2Home.

15th Annual Insect Fair

Foyer, May 5 and 6, 2001

The largest Insect Fair in the United States was hosted by the museum's permanent Ralph M. Parson's Insect Zoo and included guest speakers, informative displays, and more than 40 exhibitors with both living and preserved insects. Fun for the entire family, this is where everything "buggy" was found and questions were answered. Children took part in insect craft activities and came face-to-face with rare and endangered insects, including the giant walking stick, the African millipede, and the Madagascar hissing cockroach. Ever wondered what insects taste like? Be here next year and find out with chocolate-covered crickets, cricket lollipops and insect "treats." Still available in museum shops are insect-related books, toys, clothes, educational tools, artwork, and crafts.

This exhibit is sponsored by Western Exterminator Company.

D. Meier

The Tiniest Giants: Discovering Dinosaur Eggs

First Floor, Special Exhibits Hall, May 19 through October 14, 2001

This extraordinary exhibit features actual dinosaur eggs from the largest dinosaur-nesting site ever found in the badlands of Patagonia. Have the unique opportunity to touch 80-million-year-old dinosaur eggs and see real embryonic bones and skin—the first embryonic skin ever discovered. Amazingly, giant sauropods, the size of large buses, grew from eggs the size of a grapefruit. Join an expedition team by following the process of discovery from the field to the paleontology laboratory and walk beneath a model of a giant, 100-foot *Argentinosaurus.*

This exhibit is a joint effort between the Natural History Museum and the Carmen Funes Museum of Argentina.

L. Chiappe

Continuing Exhibits

A Communion of the Spirits: African American Quilters, Preservers, and Their Stories

Dart Gallery, Through September 3, 2001

Woven through the quilt designs on display are the on-going triumphs, struggles, and journeys of generations of African American quilters and those who have protected and preserved the quilts. Based on the book of the same title by photojournalist and folklorist Roland L. Freeman, this exhibition contains more than 200 photographs, 20 quilts, more than 40 quilted mattes, and incorporates quilts from local California quilters, along with the cultural stories they embody of family joys and pains.

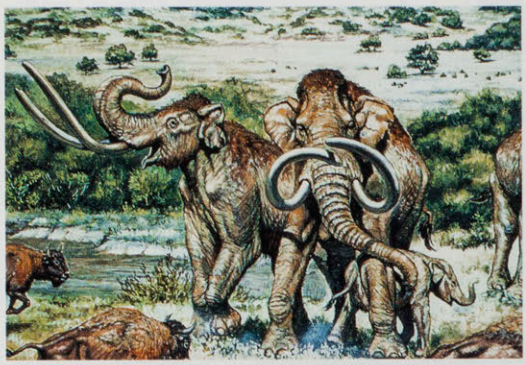
This exhibit is curated by Roland L. Freeman, produced by The Group for Cultural Documentation, and sponsored by Union Bank of California.

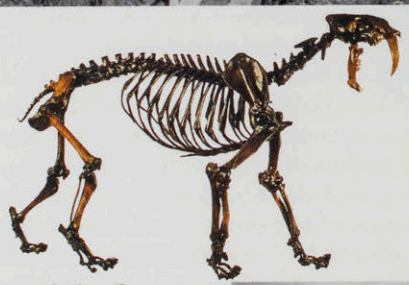
GEORGE C. PAGE
SPECIAL EDITION
ATURAL HISTORY MUSEUM
OF LOS ANGELES COUNTY

Rancho La Brea

Death Trap and Treasure Trove

Edited by John M. Harris





< Artist Pat Ortega's working drawing of extinct lions and a sabertoothed cat.

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From the Director

THE CENTRAL FOCUS OF ANY MUSEUM IS ITS collections. The George C. Page Museum of La Brea Discoveries, a satellite facility of the Natural History Museum of Los Angeles County, houses one of the most important collections of its kind—the famous fossil treasures of the "tar pits." Some of the Rancho La Brea fossils, now numbering in the millions, were among the first specimens in the collections when our museum, then Los Angeles' new Museum of History, Science and Art, opened in 1913. Today the Rancho La Brea collection forms an integral part of our scientific and cultural heritage.

The Rancho La Brea fossils document the diversity of life in southern California during the interval when man first set foot in the New World. The scientific importance of these internationally famous fossils is acknowledged by the formal designation of Late Pleistocene time in North America as the Rancholabrean Land Mammal Age. However, our ideas on how these deposits formed have changed significantly during the last 50 years, and technological advances have allowed new avenues of research on the many different kinds of animal and plant fossils from our collections.

Of particular importance is the opportunity that these abundant and superbly preserved specimens provide for assessing the effect of climatic change. We now recognize that individual accumulations of fossils each represent only a short part of the total time span in which the Rancho La Brea deposits were laid down. Radiometric dating has allowed us to place many of the samples in chronological order, with the exciting potential of being able to relate differences in the fossil animal and plant populations to environmental change. The effect of climatic change is a topic of major concern today, but meteorological records are available only for the past 100 years or so. Rancho La Brea, on the other hand, documents what happened to the local biota during cooling and warming phases of the Pleistocene Ice Age over an interval of 30,000 years and may be of crucial predictive value for the future.

Page Museum Archive

Skull of *Smilodon fatalis*, the California state vertebrate fossil and the second most common species from Rancho La Brea.

This issue of *TERRA* is devoted exclusively to the history, geology, fossils, and personalities of Rancho La Brea and is authored entirely by the staff and research associates of the George C. Page Museum of La Brea Discoveries. Many, though not all, of the individual articles were originally published in 1992 but have been updated where appropriate.

The 1992 Rancho La Brea issue commemorated the 100th anniversary of the birth of Chester Stock, a paleontologist who undertook or directed most of the original research on fossils from this incredible natural resource. Stock, who began his pivotal work in the early teens (see his biography on page 34), had planned the creation of an on-site museum, where people could see how the fossils are found and learn how paleontologists work. However, this plan was abandoned after Stock's sudden and untimely death in 1950. George C. Page, one of the Natural History Museum's most generous benefactors, never met Stock but shared the same vision. Moreover, Mr. Page had the personal resources to make it a reality. Opened in 1977, the George C. Page Museum of La Brea Discoveries continues to attract visitors of all ages from throughout the world.

Sadly, Mr. Page died at the end of last year, a few months before he would have celebrated his hundredth birthday. A tribute to this remarkable man may be found on page 52. We owe much to his generosity and foresight.

JAMES L. POWELL
President and Director
Natural History Museum of
Los Angeles County

People and the Brea: A BRIEF HISTORY OF A NATURAL RESOURCE

by George Jefferson

THE EARLIEST RECORD OF HUMAN OCCUPATION of the coastal regions in southern California is over 10,000 years old, and the oldest dated human remains in the region are from Rancho La Brea. The death and ceremonial burial of "La Brea Woman" took place about 9,000 years ago. Osteologic studies of the very incomplete remains (a skull and a dozen skeletal elements) indicate that she was 4 feet 8 inches tall (144 centimeters), and about 18 years old when she died. The cause of death is uncertain but homicide cannot be ruled out. Found buried with her were things that presumably had some significance in her life—a defaced, deliberately damaged *mano* (hand grinding stone) and the skull and partial skeleton of a domestic dog. The defaced grinding stone reflects a burial practice of southern Californian aboriginal peoples.

Although little is known of the life style of La Brea Woman's people, other than that they probably traded in asphalt, their contemporaries on the California channel islands and coastal areas had established a robust economy based on fishing. Asphalt, mined from Rancho La Brea, was exchanged throughout southern California, and used as adhesive and waterproofing by these people.

The artifacts from Rancho La Brea range in age from about 9,000 to under 4,000 years old. Although there are only 52 items, they are very well preserved. Five classes of items are represented. In addition to the grave goods found with La Brea Woman are personal possessions, food-gathering and processing tools (hunting implements and milling stones), ceremonial items (a cogged stone whose purpose may have been symbolic or ceremonial), and asphalt collecting and mining tools. A wooden spatula-shaped hair pin, a hair pin carved from deer bone, and bone and shell ornaments are among the items an individual might have carried. Several *atlatl* (spear thrower) parts including wooden dart and wooden bunt foreshafts used for hunting game, have been recovered. The function of cogged stones has been long debated. Some scholars think they were used as weights for digging sticks or fishing nets, while others believe them to be symbolic or ceremonial rather than utilitarian items.

By far the most common artifacts are associated with asphalt mining activities. These include numerous shells of scallop and other marine mollusks and wedges made from deer and elk antlers. The shells were used as asphalt containers (see Salls, p. 10), and the antler wedges were probably hafted and used as picks to mine asphalt. (Elk antlers were acquired by trade from the southern San Joaquin Valley where these animals live today; elk were never present in the Los Angeles basin, even in prehistoric times.)

THE SPANISH/MEXICAN PERIOD

Father Juan Crespi, in his diary of the Gaspar de Portola expedition which left San Diego on the 14th of July 1769, recorded the following on the 3rd of August:

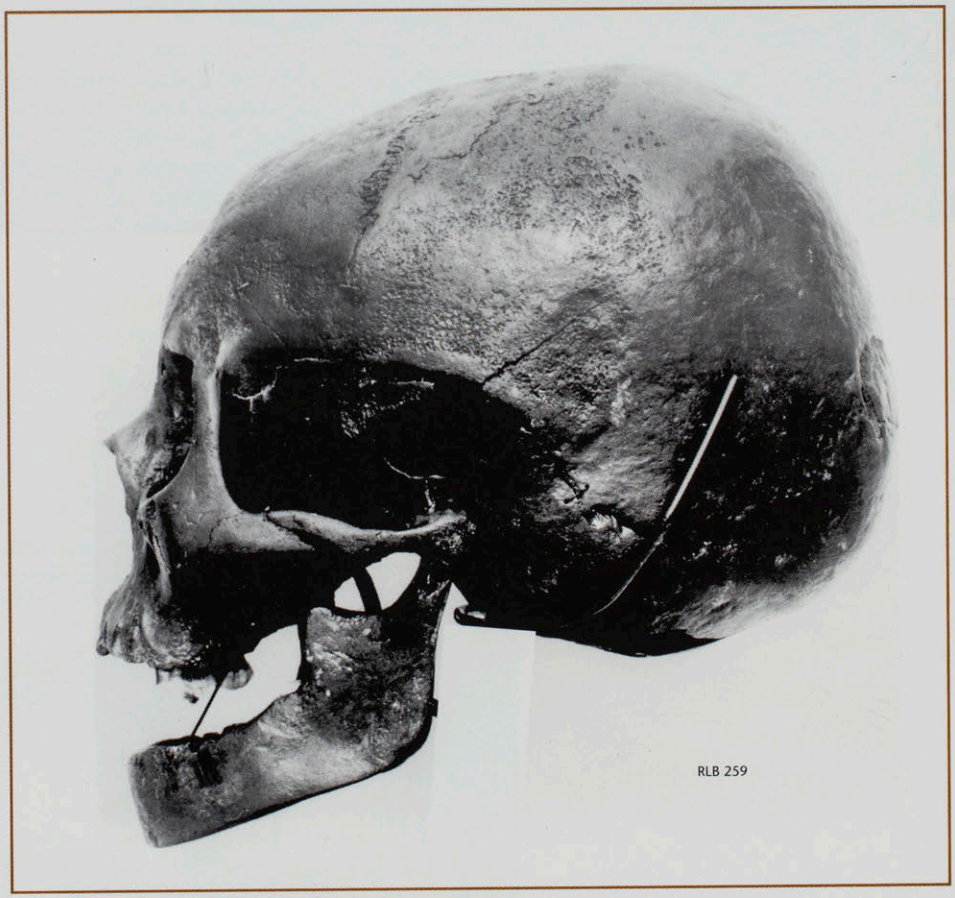
> We proceeded for three hours on a good road; to the right of it were extensive swamps of bitumen which is called *chapote*. We debated whether this substance, which flows melted from underneath the earth, could occasion so many earthquakes [a strong earthquake was noted by Crespi on July 28th].

Thirteen years later, in 1781, Los Angeles pueblo was officially established under Spanish rule as El Pueblo de Nuestra Señora la Reina de Los Angeles. In 1792, José Longinos Martinez described a trip through the area:

> Near the Pueblo de Los Angeles there are more than twenty springs of liquid petroleum, pitch, etc. Further to the west of the said town, in the middle of a great plain of more than fifteen leagues in circumference, there is a great lake of pitch, with many pools in which bubbles or blisters are continually forming and exploding. ...In hot weather animals have been seen to sink in it and

RLB 1970C

A patch of different colored plaster fills in bone missing from the top of the La Brea Woman skull. This damage could have been caused during life by a blow to the head with a blunt object but may instead have occurred before reburial or during excavation. The left side of the lower jaw was also broken.



RLB 259

The skull of La Brea Woman as it was mounted for display in 1915.

> when they tried to escape they were unable to do so, because their feet were stuck, and the lake swallowed them. After many years their bones have come up through holes, as if petrified.

Longino's reference to petrification is interesting because, for the next century, people believed that the bones found in these asphalt swamps were from domestic animals or resident wild animals.

Following independence from Spain, the territory came under Mexican control in 1822. Although Rancho La Brea was never a Spanish land grant, in 1828 the *alcalde* (mayor) of Los Angeles, José Antonio Carrillo, granted Antonio José Rocha and Nemesio Dominguez the rights to Rancho La Brea. The property was described as one square league of land, 4,439.07 acres, including the eastern portion of Rancho Rodeo de las Aguas and extending north and east from Rancho Las Cienegas to the Santa Monica mountains. Rocha was a Portuguese sailor who had deserted the *USS Columbia* 13 years earlier and had successfully established himself in Los Angeles. Under provisions of the grant, Rocha agreed to allow the citizens of Los Angeles to continue to mine as much *brea* as needed for personal use, which included primarily roofing. A provisional land claim was issued to the Rocha family in 1840 by the Mexican governor of California, Juan Bautista Alvarado.

"A very large amount of the hardened asphaltum, mixed with sand and the bones of cattle and birds which have become entangled in it, lies scattered over the plain."
—Geologist J. D. Whitney, 1865.

In 1850, two years after the end of the United States' war with Mexico, California achieved U.S. statehood. The Rocha family then appealed to the U.S. government to have the Mexican land grant confirmed under the treaty of Guadalupe Hidalgo. Because the deed was provisional and the boundary of the Rancho poorly defined, an expensive and prolonged court struggle resulted. The Rocha claim was eventually honored by the U.S. Supreme Court in 1870. However, to cover court costs, portions of the Rancho were sold or deeded for legal services. By this time, John and Henry Hancock had acquired a major part of the original Mexican land grant.

The citizens of Los Angeles continued to use the asphalt as State Geologist, J. D. Whitney (after whom Mount Whitney is named), reported in 1865:

> About seven miles due west of Los Angeles is the most important of the numerous tar springs seen in this vicinity. It is from here that most of the asphaltum used in the town is obtained.... A very large amount of the hardened asphaltum, mixed with sand and the bones of cattle and birds which have become entangled in it, lies scattered over the plain.

Like Martinez 70 years earlier, Whitney did not recognize the animal remains at Rancho La Brea as fossils.

THE HANCOCK MINE

Major Henry Hancock, who assumed control of the rancho in the early 1870s, was a prominent Los Angeles citizen. He had been a representative in the

Seaver Center general file photo 3502

In 1828, the rights to Rancho La Brea were granted to Nemesio Dominguez and Antonio José Rocha. Here, Rocha's son, also named Antonio, sits on the porch of his adobe in 1871 with his wife, Bentura. Around them are their children, grandchildren, and a visiting child, far right.

RLB 58

A view northward from Rancho La Brea shows a common problem after the storms in February 1914: a flooded excavation.

California State Assembly, and as a U.S. Surveyor had mapped much of Los Angeles for real estate development. The Hancocks established a commercial mining operation with the asphalt ore deposits. Chinese immigrants, who had worked in the gold fields and railroads, provided the labor. Brown *brea*, used as fuel, was mined and sold by the wagon load at between four and five dollars per ton to local industries such as Capitol Woolen Mills and the Home Ice Company. Refined asphalt was shipped from Santa Monica harbor to San Francisco where it sold for between ten and twelve dollars per ton. It was first used as a preservative for pipes and railroad ties, and later for cementing cobblestone pavements in the city.

At about the time the Hancock family had consolidated their ownership of Rancho La Brea, William Denton, a professor from Wellesley, Massachusetts, visited the noted asphalt deposits. Denton was the first geologist/paleontologist to recognize that the animal remains from Rancho La Brea were fossils. In 1875, he reported the occurrence to the Boston Society of Natural History as follows:

> The locality is known as Major Hancock's Brea Ranch and is about eight miles west of Los Angeles, in the valley of Santa Anna [sic]. The bed of asphaltum here covers sixty to eighty acres, and at a depth of thirty feet, no bottom has been reached. Thousands of tons have been removed for roofing, paving and combustion, but the supply is almost inexhaustible. Major Hancock had about twenty-five Chinamen employed in digging out the best of the asphaltum ....The material was conveyed to large open boilers, in which it was boiled for twenty-four hours, and then run into sand molds; subsequently it was broken up, ...carted nine miles and shipped to San Francisco, where it was sold for twenty dollars a ton for making pavement....Major Hancock presented me with what I found to be a canine tooth of *Machairodus* [an early name for sabertooth cats],

J.Z. Gilbert Collection

The Southern California Academy of Sciences excavation, conducted around 1910, was directed by J. Z. Gilbert of Los Angeles High School. The site was located 130 feet southeast of the Hancock ranch house, which appears in the background.

RLB 2389 Gilbert Collection

The "skull room" was located in the basement of the south wing of the new Los Angeles County Museum of History, Science and Art on Exposition Boulevard. This photo was taken in 1926. The skulls on the shelves are of carnivores; note the American lion skull on the near end of the table.

> a great sabre-toothed feline. It was found at the depth of fifteen feet in the asphaltum....The crown of the tooth is broken, and its entire length could not have been less, I think, than eleven inches.

Denton also reported the occurrence "of teeth of the fossil horse, and the bones of the deer, a large bovine animal...and other animals." Apparently, Denton's account of fossil animals from the asphalt mine at Rancho La Brea went largely unnoticed in the paleontologic community.

THE FOSSIL COLLECTORS

It was not until 1901 that Rancho La Brea fossils again attracted scientific attention. Remains of an extinct species recovered during the drilling of a water well just north of the Hancock ranch house were identified by W. W. Orcutt, a well known Los Angeles geologist. By 1905, he and paleontologist F. M. Anderson had assembled a modest collection in-

"Major Hancock presented me with what I found to be a canine tooth of Machairodus, *a great sabre-toothed feline."*
—Prof. William Denton, 1875.

cluding the skulls of a sabertooth cat (*Smilodon*) and dire wolf (*Canis dirus*), and dermal ossicles (skin bones) from the giant ground sloth (*Paramylodon*). Anderson contacted Dr. J. C. Merriam, a vertebrate paleontologist at the University of California, Berkeley, who visited Rancho La Brea that year. An excavation team from Berkeley returned to collect in 1906. In 1908, Merriam published the first account of Rancho La Brea fossils since William Denton's 1875 description of Hancock's asphalt mine.

Soon, other members of the local paleontological community realized the importance of the fossiliferous deposits. Among them were Dr. L. H. Miller of Los Angeles Normal School (later the University of California, Los Angeles), J. Z. Gilbert of Los Angeles High School, Dr. Bebb of the Dental College at the University of Southern California, and Mr. E. Fischer who was affiliated with the Southern California Academy of Sciences and Occidental College. With Madame Hancock's permission, all assembled substantial fossil collections. Dr. Miller later recalled his 1907 meeting with Mr. Fischer, a private collector at the time, who was working in an abandoned University of California excavation.

> I could only come out there on weekends.... Each week the pit would be visited by a good number of amateurs, and bones that were left there one week would be gone the next. I'd catch the west-

> bound car out on 16th street and get off several hours later at a little flag stop out in the grain fields. I would walk... for about three-quarters of a mile till I got to the diggings.... I'd spend the remainder of the day extracting bones from the tar.

Apparently, there was little on-site control over the property. The family had left the ranch and relocated in Los Angeles. Salt Lake Oil Company leases, to the north and east of what is now Hancock Park, had been very profitable. Furthermore, under Allen Hancock's direction, the Rancho La Brea Oil Company brought 71 wells into production.

Gilbert, under the auspices of the Southern California Academy of Sciences, opened a major excavation in 1909. With students from Los Angeles High School, he worked a site 130 feet (40 meters) southeast of the Hancock ranch house. The academy excavation was supported with funds primarily from the City and County of Los Angeles. A year later, it was the relationship between the academy and Los Angeles County that led to the establishment of the Museum of History, Science and Art, which later became the Natural History Museum of Los Angeles County. The academy collection that had been stored at Los Angeles High School was moved to the new museum in 1911, and mounted skeletons from Rancho La Brea were exhibited in the museum's new science hall when the museum opened in 1913.

By 1912, J. C. Merriam secured funding for renewed U.C. Berkeley excavations. Digging started in August 1912 and lasted through April of 1913. The project was directed by R. C. Stoner, a graduate student under Merriam. For the first time since excavations had begun at Rancho La Brea, a grid-controlled excavation system was used to keep record of the location from which each bone was taken. The method set a paleontological standard and, in a refined form, is used in the museum's present excavation in Hancock Park at Pit 91. Interestingly, Chester Stock, who was to become the most important scientist to work at Rancho La Brea, was a junior member of Stoner's excavation team.

One month after Stoner completed the U.C. Berkeley excavations, the new Museum of History, Science and Art began work at the site. Allen Hancock granted the museum exclusive rights to excavate for a two-year period, and donated all the fossils recovered to the museum in honor of his parents. Later, the 23 acres now known as Hancock Park was donated to the County of Los Angeles with the understanding that a museum would be built on-site to house and exhibit the fossils.

Between July 1913 and December 1915, the museum's aggressive excavation effort, headed by L. E. Wyman, explored 96 asphalt deposits (called pits) and, with a crew of up to 14 men, collected over three-quarters-of-a-million bones. Although wages were reasonable for 1913-1915 (experienced excavators earned $3.50 per day), by modern standards, the working conditions were dangerous. Even though several of the excavations reached depths of over 30 feet, shoring was minimal and primitive, cave-ins were common, and the pits flooded with each rain.

The fossil bones were scrubbed clean of asphaltic sediment in containers of kerosene. The kerosene

RLB 53

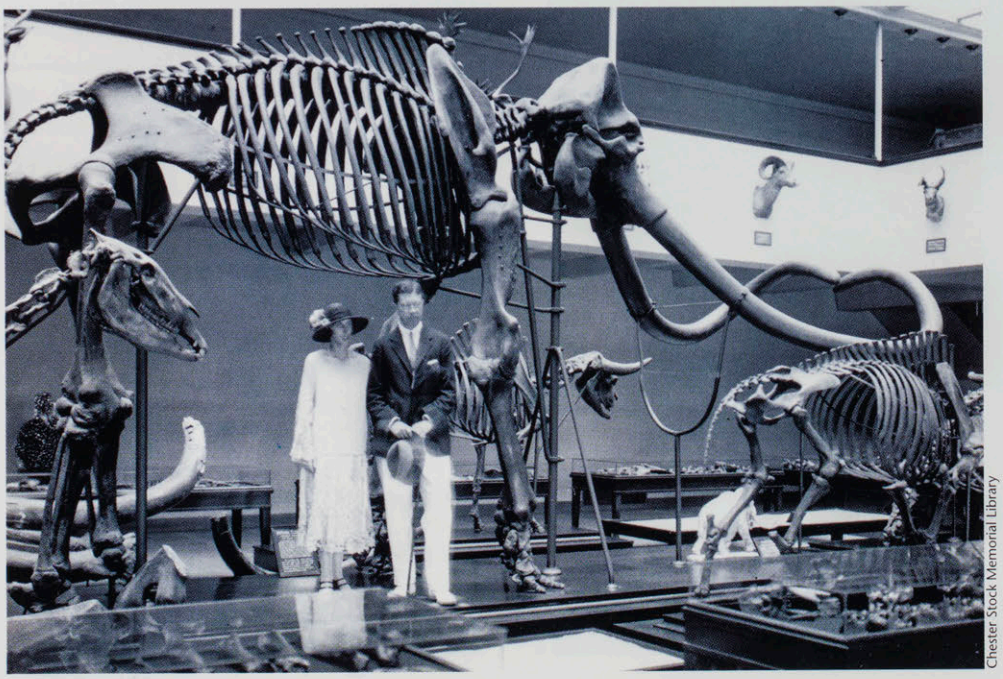
Cleaning tar from bones at the Rancho La Brea excavations, February 1914.

LEFT

The first major exhibits installed in the new museum were mounted skeletons of the animals recovered from Rancho La Brea. These soon attracted international attention. Here, Crown Prince Gustav and Princess Louise of Sweden pose in 1926 in front of the mammoth skeleton that was later placed on exhibit in the Page Museum.

BELOW

Fossil proboscidean bones exposed in Pit 9.



Chester Stock Memorial Library

RLB 93

About 11 a.m. on September 4, 1915, this block of fossils from Pit 81 was loaded aboard a mule-drawn wagon to go to the museum at Exposition Boulevard. Note the low-bed wagon designed for easy loading. The box measures about four feet across.

RLB 355

View of the west rim of Pit 3, January 26, 1914. Water is being pumped out next to a cave-in along the east wall.

RLB 28

Although wages were reasonable for the time (experienced excavators earned $3.50 per day), by modern standards, the working conditions were dangerous. Shoring was minimal and primitive, cave-ins were common, and the pits flooded with each rain.

was preheated in tubs over a *brea*-fueled stove. After excavation data were recorded and inked on many of the specimens, the boxed bones were carried by mule-driven wagon to the museum where they were sorted and catalogued. Soon after, skeletons of the larger mammals such as the mammoth (*Mammuthus*) were assembled for exhibit. Many of these earliest mounts have been restored and are exhibited in the Page Museum. Of note is Pit 81 which was opened in May of 1915. By August, it was decided to move the bone mass exposed in the floor of the excavation *en bloc* to the museum, and on the 4th of September Wyman recorded:

> North wall cracking badly, hence a heavy stull placed across pit to opposite wall. Canvas removed and locality cleaned up generally. All ready for expert movers to do their work. Truck, with three men, four big mules, and all sorts of jacks, blocks and tackle, reached scene at 10.15 a.m., through

the open field to the west. At 12.15 p.m. Pit No. 81 was on the truck and starting for the Museum, where the load was discharged at 4.30 p.m.

The Pit 81 block is now on exhibit in the Page Museum.

For two months each summer, excavation continues in Hancock Park at locality LACM 6909, the original site of Pit 91 where digging started on June 13th, 1915. In July of that year, Wyman recorded the following:

> Holland has exposed bones at a depth of 10 ft. in the extreme west (or northwest) end of cut. Cleaning up whole mass to be held as a 'showpiece'.... Wall across northwest and southwest sides of latest extension caved out underneath, back a distance of 4-ft. in places. Cutting down and removing all this cracked portion, which will materially enlarge the excavation, and sloping the walls to prevent, if possible, another slide-in. It is planned to hold this pit as a permanent 'exhibit' hence digging operations are suspended, and pit will be timbered and roofed to protect it against caving and storms.

Unfortunately, the excavation was never roofed or timbered, and eventually the walls failed and the pit filled in with debris. However, because an intact bone mass remained buried in Pit 91, the site was selected as the locus for a renewed, state-of-the-art excavation, which began 54 years later to the day, on June 13th, 1969.

George T. Jefferson began his career at the Page Museum when it opened in 1977, and served as head of the Rancho La Brea Section from 1983 to 1993. He is currently the Paleontologist for the Colorado State Desert District of the California Department of Parks and Recreation.

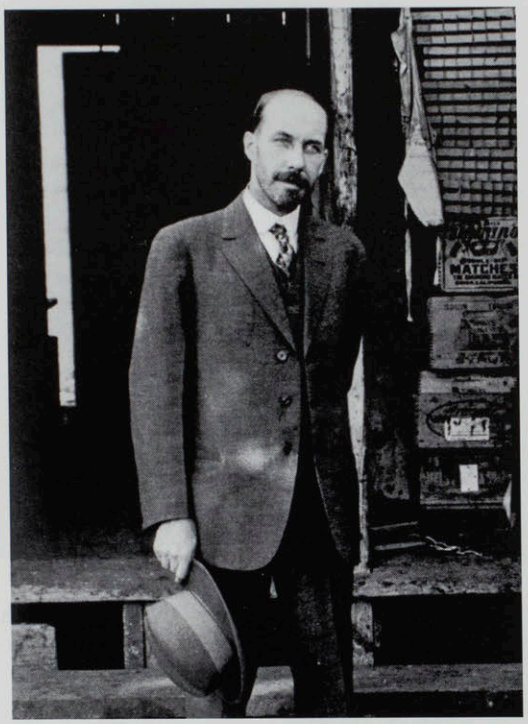
Avenues of Research

by L. F. Marcus

FROM THE TIME OF THE FIRST EXCAVATIONS, Rancho La Brea was recognized as one of the most important fossil localities in the world. There were scientific publications on fossil mammals by U.C. Berkeley zoologist J. F. Bovard in 1907, on insects by F. Grinnell in 1908, several papers by J. C. Merriam between 1906 and 1912, and a semi-popular review by Los Angeles High School biology teacher J. Z. Gilbert in 1910. Other articles on the fossil mammals were published, and U.C.L.A. avian paleontologist L. H. Miller described the fossil birds, launching a long series of publications.

In 1911, Merriam began a series of monographs on Rancho La Brea. These publications and a group of popular papers summarized what was known about the history and geology of the site. The popular articles helped to set the tone for subsequent interpretations of the deposits. A *Sunset* magazine feature in 1908 was titled "Death Trap of the Ages," and *Harper's Weekly* in 1909 published another Merriam article with the title and subtitle "A Death-trap which Antedates Adam and Eve: the Discovery of a California Tar-swamp that Holds the Bones of Extinct Monsters."

By 1930, most of the species from Rancho La Brea which were new to science had been described, and the major features of the collection of mammals and birds were known. This descriptive phase



RLB 69

John C. Merriam organized the first scientific excavations at Rancho La Brea undertaken by the University of California, Berkeley. He wrote the first scientific account of the site and published preliminary and monographic descriptions of many of the mammalian fossils.

continued through the following two decades and was largely completed by the late 1950s. Major contributors included L. H. Miller, Hildegarde Howard (see p. 45), and Chester Stock (see p. 34). Surprisingly, there was little research on the evolutionary history of species represented by large numbers of specimens, such as sabertooths, dire wolves, horses, sloths, and bison or the abundant eagles and teratorns. This seemed to be due to the then prevalent belief that the fossiliferous deposits were mixed through time. The absolute time span represented at Rancho La Brea was unknown.

The invention of radiocarbon dating in the 1950s allowed the deposits to be dated for the first time. Large series of dates were able to show that the vast collections could be partitioned into separate time

intervals. The 1960s saw the demonstration of a clear layering of the fossil accumulations, and explanation of the tar traps in the context of flood plain deposits. This interpretation destroyed the earlier picture of "tar pits" where animals became mired and sank out of sight, but the pit-like excavations, which later became filled with water, helped to reinforce the old misconception of the deposits as traps filled with gooey "tar."

When Pit 91 was reopened in 1969, painstaking and detailed collection—centimeter by centimeter—could be done for the first time. Geologic features were carefully recorded, and as each fossil was removed from the deposit, its position and orientation were documented. Modern shoring averted all of the flooding and caving problems that had plagued the earlier collecting efforts.

A new research emphasis was the description of the plants and smaller animals, including insects. The paleoecology of the site was considered significant, and detailed and innovative examination of age at death, tooth wear, and other features of the fossils (previously ignored) led to an understanding of life histories and even social behavior in the more abundant animals. As older collections were restudied and the fossils from the new excavations were examined, additional previously undescribed species were recognized at Rancho La Brea, even among the well-known animals.

Quantitative evolutionary studies of the huge series of mammals and birds are underway, and the rate of change can be determined from the large number of available radiocarbon dates. Rancho La Brea preservation is excellent, so that even bone protein fibers can be examined using electron microscopy, and their chemistry analyzed. DNA in bone is also well preserved; perhaps sequencing of nucleic acids for some fossil species will be accomplished, allowing us to determine the animal's placement in the evolutionary tree.

Although much is presently known about the associations of plants and animals, about their life histories, and about their behavior and local abundance during the last Ice Age, new studies will document changes in climate, landscape, and local environment. For example, analyses of fossil pollen from Rancho La Brea will provide a local vegetational history, bringing an understanding of the sequence of environmental changes prior to the terminal extinction of the larger animals.

Dr Leslie F. Marcus is a Rancho La Brea research associate. The computerization of Rancho La Brea Hancock Collection catalogues was performed by Dr. Marcus in the early 1960s. He has been responsible for much of the radiometric dating done on Rancho La Brea fossils.

Ancient Brea People

by Roy Salls

THE POSSIBILITY THAT CULTURAL ARTIFACTS might be found in the asphaltic deposits of Rancho La Brea was suggested by the discovery of an isolated projectile point during the University of California excavations of 1912, and confirmed by the Natural History Museum two years later. On October 28th, 1914, L. E. Wyman (project supervisor) directed J. E. Hayes and A. Phipps to excavate the wall between Pits 61 and 67. As work proceeded Wyman's belief that the two excavations penetrated the same deposit was confirmed. While removing the material between the two sites, Hays recovered a piece of wood that appeared to have been worked by human hands, "almost as perfect as though turned by a lathe." After the discovery of this artifact, which was identified as the foreshaft of an *atlatl* dart, numerous other artifacts were recovered from the same deposit. In addition to the artifacts, many large marine mollusk shells were found, leading Wyman to speculate that an aboriginal camp was once located nearby.

Dr. A. Woodward, curator of anthropology at the museum, compared the artifacts with others found throughout southern California. Dr. M. R. Harrington, of the Southwest Museum, noted that the wooden *atlatl* dart foreshafts resembled those from Gypsum Cave, Nevada, where ground sloth remains had been recovered. Both he and Woodward therefore reasoned that the *atlatls* were as old as the extinct animals from Rancho La Brea. Radiometric dating techniques have now shown that the *atlatl* foreshafts from both Gypsum Cave and Rancho La Brea are between 4,450 and 2,900 years old, whereas the sloth remains are about 11,600 years old.

RLB 1892C

The artifacts recovered from Hancock Park indicate that the asphalt deposits have been utilized at least since the Millingstone Period of southern California prehistory, 3,000 to 9,000 years ago. Millingstone Period artifacts from Rancho La Brea include milling/grinding stones such as *manos* and *metates*, bone hairpins, and a cogged stone. The Intermediate (1,000 to 3,000 years ago) and Late Prehistoric Periods (1,000 to AD 1769) are represented by double-drilled abalone shell pendants, awls, shell scoops, and elk antler wedges.

As was noted by Wyman, an abundance of marine bivalve shells were recovered from Pit 67. These were brought to the site or acquired through trade from the coast. In the collection is a spiny cockle shell (*Trachycardium quadragenarium*) that was cut and hafted for possible use as a asphalt scoop. In fact, it was once believed that most of the shells were used to scoop up liquid asphaltum. The vast majority of shells are from the small speckled scallop (*Argopectin aequisulcatus*). A more reasonable use for these shells has been recently discovered. In 1985, a prehistoric basketry pouch that contained fishing gear and several bivalve shells filled with asphalt was recovered from an archaeologic site on San Clemente Island. Many of the fishhooks in the pouch had asphalt applied to one end as an adhesive for attachment of the fishing line. Apparently, asphalt-packed shells were important elements in the aboriginal fishing kit. Furthermore, these convenient containers could be easily transported.

Wyman was probably correct in that an aboriginal camp was located in Hancock Park. During excavation of the Shin'enkan wing of the Los Angeles County Museum of Art (north of Pit 67) a cogged stone fragment and lithic debitage (chipping waste from the manufacture of stone artifacts) were encountered. Although numerous artifacts such as marine shells and antler wedges indicate asphalt mining, the hunting and food processing implements suggest that considerable time at the seeps was also spent in subsistence activities while the asphaltum was being gathered and packaged.

The late Roy Salls was a Rancho La Brea research associate and Director of the Lompoc City Museum in Ventura County.

4681 Page Museum Archives

This broken half of a basalt cogged stone from Pit 61/67 has a thumbnail-sized fragment that was glued back on with asphalt. Cogged stones could have been used as weights for digging sticks or fishing nets, but may have served a strictly ceremonial purpose. They are typical of coastal archaeological sites in southern California that have been dated between 4,000 and 5,000 years old.

4682 Page Museum Archives

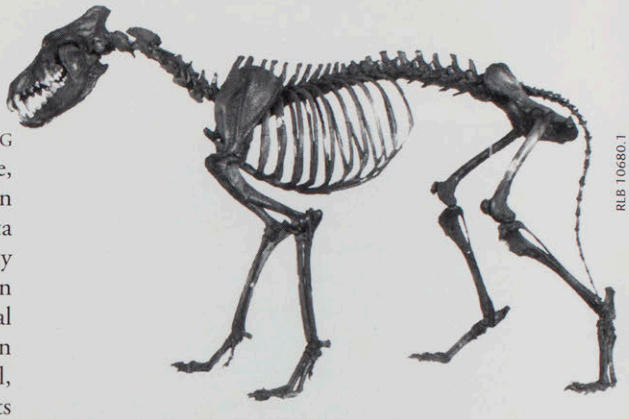
Artifacts recovered from Rancho La Brea include, from right to left, a hairpin carved from a deer cannon bone, the tine of an antler that was used as a pressure flaker in making stone tools, and *atlatl* foreshafts.

LEFT

Two planks from a southern Californian plank canoe showing use of asphalt by early Native Americans. Planks were hewn with stone tools, lashed together by rope, and then caulked with asphalt.

Reconstructing a Late Pleistocene Environment

by John M. Harris



RLB 10680.1

Skeleton of extinct dire wolf *(Canis dirus).*

GEOLOGICAL STUDIES SUGGEST THAT DURING the last phases of the Pleistocene Ice Age, the topography of the Los Angeles Basin was much like it is today. The Santa Monica mountains overlooked a gently sloping plain left by the retreat of the Pacific Ocean about 100,000 years ago. Permanent and seasonal streams and rivers drained from the mountains en route to the ocean and added thin veneers of gravel, sand, and clay to the plain. It was through faults and fissures in these alluvial sediments that asphalt migrated upwards from the underlying oil-bearing deposits, forming surface seeps of varying size in low-lying areas. The remains of animals and plants that lived and died in or at the edges of the streams and ponds dotting the outwash plain, or that were inadvertently caught up in the asphalt seeps, were in turn covered by sediment deposited during times of flood. These fossilized remains in essence provide a record of the habitats that were present in the basin between 40,000 and 9,000 years ago.

An incredible diversity of animal and plant life is represented in the Rancho La Brea asphaltic deposits. More than 600 species have been documented to date, and the total continues to grow as the result of ongoing studies and continuing excavation. At the time this article was prepared, well over a million bones were present in the collections—representing 58 species of mammals, 138 species of birds, 24 species of reptiles, 6 species of amphibians, and 3 species of fish. There are more than 50,000 mollusk shells representing 56 species; most are freshwater clams, freshwater snails, and land snails, but there are some marine forms. Several hundred thousand often fragmentary fossils document the presence of 168 kinds of arthropods. The plant remains have been less intensively studied, but 75 microscopic diatom species have been recognized and another 80 kinds of plants are represented by pollen, seeds, leaves, or wood.

Kinds of preservation that are rarely encountered elsewhere— cartilaginous rings from the windpipes of birds, fleshy parts of leaves, and iridescent coloration in beetle wing covers—occur frequently at Rancho La Brea.

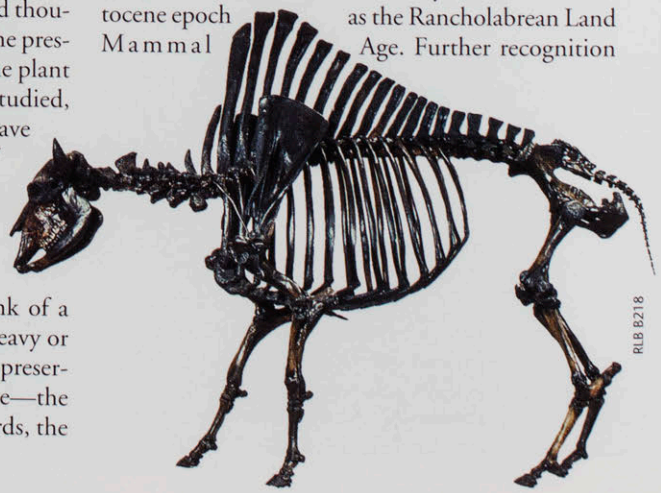
The fossils range in size from those that cannot be seen without the aid of a microscope to large specimens—such as the trunk of a 16,000 year old cypress tree—that are too heavy or bulky to be carried by one person. Kinds of preservation that are rarely encountered elsewhere—the cartilaginous rings from the windpipes of birds, the fleshy parts of leaves, and iridescent coloration in beetle wing covers—occur frequently at Rancho La Brea, and the quality of bone preservation is in many cases spectacular. Other instances of unusual preservation include fossilized blow fly larvae within some of the bones, plant fragments in crevices of the teeth of some of the extinct herbivores, and dire wolf penis bones.

What most impresses visitors behind the scenes at the Page Museum, however, is the overwhelming quantity of fossil material that has been recovered from the vicinity of Hancock Park during the last nine decades. Row upon row of fossil-filled cabinets extend around the periphery of the public portion of the museum, underscoring the fact that Rancho La Brea is one of the richest sources of Pleistocene fossils anywhere in the world and constitutes an osteologist's paradise. Many of the vertebrate species are represented by male and female individuals that range in maturity from the newly born to the elderly adult. Some specimens show the effects of naturally occurring injury or potentially crippling disease. The most common species are sometimes represented by thousands of individuals. In all, the collection is a treasury of information on life in the Los Angeles Basin during the waning phases of the last major ice age.

The scientific importance of the "treasures from the tar pits" has been recognized from the turn of the present century. It culminated in 1951 with the designation of the last 400,000 years of the Pleistocene epoch as the Rancholabrean Land Mammal Age. Further recognition

Publications Office Ed Ikuta

Skeleton of extinct Harlan's ground sloth *(Paramylodon harlani).*



RLB B218

RIGHT
Skeleton of ancient bison *(Bison antiquus).*

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This vignette from the Hallett mural shows one *Smilodon* feeding from the carcass of a horse while its companion fends off a dire wolf *(Canus dirus)*. This asphalt need only to have been a few inches deep to trap most of the largest kinds of mammals represented in the Rancho La Brea fauna.

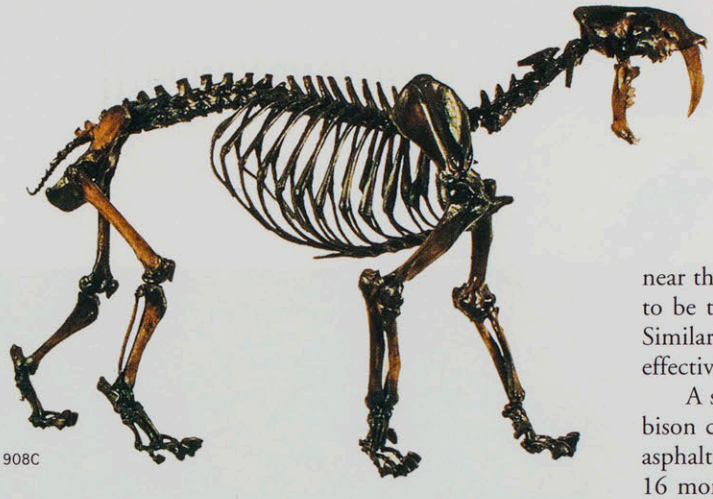
occurred in 1963 with the designation of Rancho La Brea as a National Natural Landmark by the National Parks Service. The potential of this resource has, however, scarcely been tapped—largely because of the common misconception that the meticulous work done by Chester Stock and his colleagues during the first part of the century had documented most of the important aspects of this unique biota.

It is certainly true that many of the most abundant larger mammal and bird species were described in detail prior to 1950. But more recent investigation of the smaller vertebrates, invertebrates, and plants affords more comprehensive information about local environmental conditions during the last phases of the Pleistocene Ice Age. Moreover, it now seems clear that the fossils were not all churned up together in natural asphalt cauldrons over the course of 30,000 years but instead represent a series of discrete and short-lived episodes of fossilization. Each individual accumulation provides a sample of the animal and plant populations present at Rancho La Brea during a time interval of a few thousand years. When individual samples have been dated and fully studied, it may be possible to link broad-scale climatic fluctuations at the end of the Pleistocene with changes in local plants and animals within the Los Angeles Basin.

Rancho La Brea is an osteologist's paradise. The most common species of animals are sometimes represented by thousands of individuals ranging in maturity from the newly born to the elderly adult.

THE RARE, THE ABSENT, AND THE ANOMALOUS

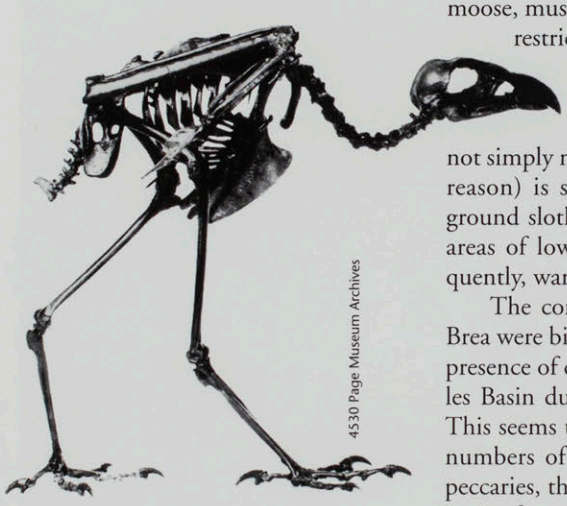
Mammals from about 135 genera are known to have been living in North America in late Pleistocene times, and remains of more than one-third (48) of these have been recovered from Rancho La Brea. Considering that nearly half of the known North American late Pleistocene mammals were small animals with restricted geographic ranges (rodents, bats, insectivores, hares, etc.), the Rancho La Brea



Skeleton of extinct sabertooth *(Smilodon fatalis).*

RLB 1908C

mammal fauna does appear impressively complete. About half of the extinct mammalian genera represented in late Pleistocene deposits from North America occur at Rancho La Brea, and more than two-thirds of the genera of larger mammals that still persist today also occurred within the Rancho La Brea biota. Unrepresented extant mammals were for the most part forms such as wolverines, martens, moose, musk oxen, saiga, and caribou that are now restricted to the cooler northern part of the continent. That these were naturally absent from the southwestern United States during the late Pleistocene (and not simply missing from our fossil records for some reason) is suggested by the presence instead of ground sloths, which otherwise seem restricted to areas of low latitude, low elevation, and, consequently, warmer temperatures.



4530 Page Museum Archives

Skeleton of extinct La Brea Caracara *(Polyborus plancus prelutosis).*

The common large herbivores at Rancho La Brea were bison, horses, and camels, suggesting the presence of dry and open habitats in the Los Angeles Basin during the later part of the Pleistocene. This seems to be confirmed by the relatively small numbers of mastodons, deer, tapirs, llamas, and peccaries, that would have browsed or sought shelter in forested areas. Remains of mammoths are found only in the earlier part of the Rancho La Brea deposits and this, too, may be related to available habitat. However, daily and seasonal variations in temperature affect the viscosity of asphalt, and may have some bearing on the kinds of animals that became trapped and preserved as fossils.

There are fewer owls and small nocturnal mammals from the deposits than might be expected from their relative abundance today. This can be explained by the fact that asphalt is far less sticky when cool. Small animals and their predators that were only near the asphalt seeps at night would be less likely to be trapped than those present during the day. Similarly, the "asphalt trap" would have been less effective in the cooler months of the year.

A study of bison teeth has indicated that only bison calves of certain ages are represented in the asphaltic deposits: calves of 2-4 months old, or 14-16 months old, or 26-28 months old. Either the asphalt only trapped the calves during the two warmest months of the year (an interval that would have begun 60 days after the annual spring calving episode) or, more likely, the calves were only present in the basin for two months of each year. If bison herds were only present in the basin for part of each year, perhaps to take advantage of the annual spring flush of vegetation following the winter rains, it is possible that the small numbers of some other herbivore groups could also be explained by their presence only during the cooler months.

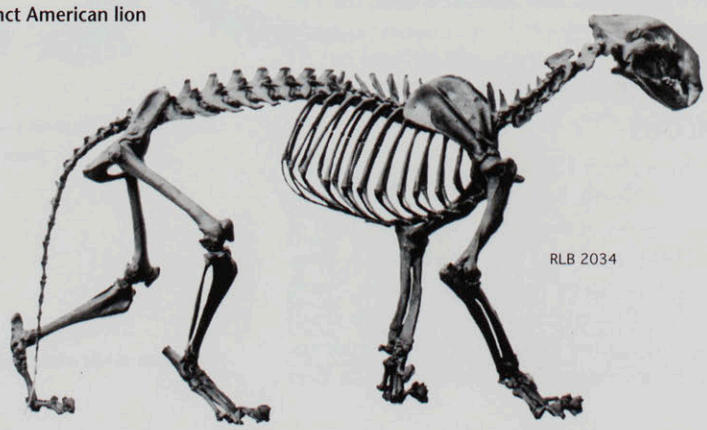
Some of the animals represented in the asphaltic deposits, such as the domestic dog and sheep, evidently accompanied humans into the region. Remains of the tule elk, and some marine snails and clams, are also known from Rancho La Brea only in the context of human artifacts. The presence of other marine species is more difficult to explain, but perhaps some of the microscopic diatoms and ostracods were transported by onshore winds, and the smaller marine clams and snails could have been brought inland by shore birds.

LONG- AND SHORT-TERM CHANGES

Radiometric dates for fossilized bone and wood from Rancho La Brea indicate that fossils were deposited between 9,000 and 40,000 years before the present. This time interval coincides with the last major cool episode (Wisconsinan) of the Pleistocene Ice Age, the coolest part of which occurred about 20,000 years ago. Some early studies of the limb bones of the dire wolf and sabertooth indicated that the overall size of these particular carnivores increased during the 30,000-year interval (increase in size through time is a common phenomenon within the fossil record). However, more recent investigations of the Rancho La Brea herbivores (specifically the ground sloths, horses, and bison) have suggested that the body size of these animals varied according to their geologic age in apparent response to changes in the prevailing temperature and rainfall. Interpretations of this nature depend on accurately determining the sex, maturity, and geologic age of individual specimens from the available samples. Such studies are still at a preliminary stage but offer intriguing potential for evaluating short-term effects of climatic fluctuation on mammal species.

The ultimate goal will be to document how Pleistocene climatic change affected the different

Skeleton of extinct American lion *(Panthera atrox).*



RLB 2034

elements of the flora and fauna of the Los Angeles Basin. Most of the previous excavations were undertaken in the younger deposits although, except for the vertebrate fossils, only the plants and invertebrates from the older units have been studied. Further study and dating of the existing samples, and perhaps further excavation, will be needed before this goal may be achieved.

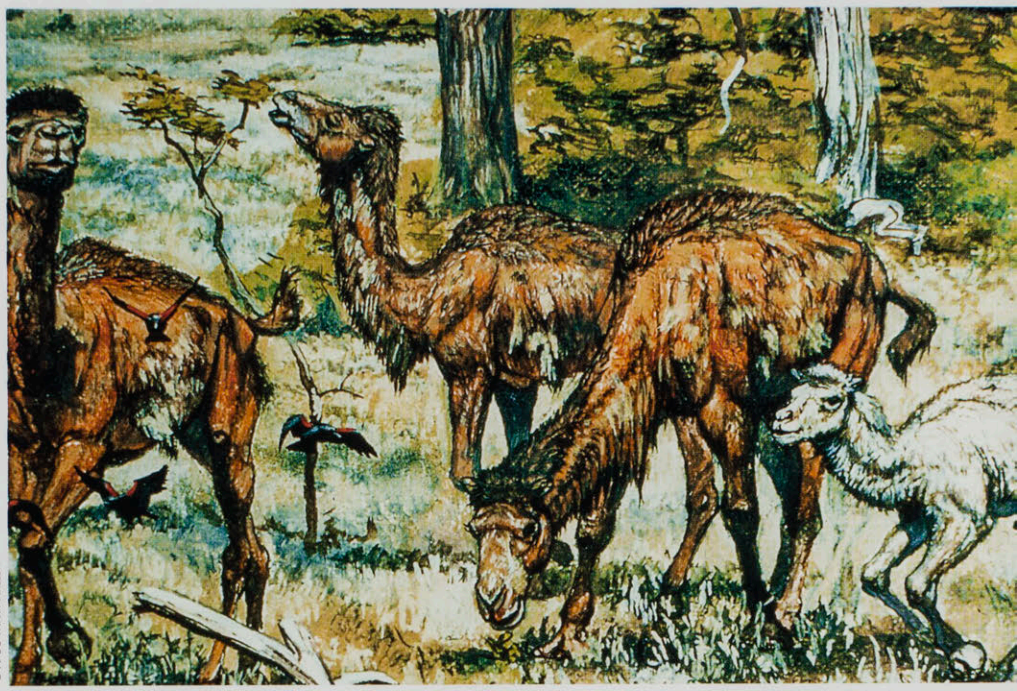
AN OVERABUNDANCE OF CARNIVORES

One feature that distinguishes Rancho La Brea's mammal and bird assemblages from those of other fossil sites, regardless of their geologic age, is the preponderance of carnivorous species. Herbivores far outnumber carnivores in today's ecosystems and the same is normally true of fossil assemblages. In the Rancho La Brea deposits, however, the dire wolf is by far the most common mammal recovered, followed by the sabertooth and the coyote. Altogether, carnivores constitute nearly 90 percent of the fossil mammals in the collections of the Page Museum. A similar discrepancy is encountered in the fossil birds: nearly 70 percent are birds of prey (eagles, vultures, owls, and their extinct relatives). Even allowing for possible bias of earlier excavators, who may have found the larger carnivores and raptors more interesting or more desirable as additions to the collections, these proportions are, to say the least, unusual.

One plausible explanation for the unusual proportion of carnivores in the Rancho La Brea assemblages is the unique way in which the asphaltic seeps sampled local populations. For every large herbivore in the collections there is a sabertooth, a coyote, and four dire wolves. These proportions, so unlike those of natural communities, suggest that the carnivores

Some of the animals represented in the asphaltic deposits, such as the domestic dog and sheep, evidently accompanied humans into the region.

became selectively trapped when feeding from herbivores that fell victim to the seeps. The large number of flesh-eating birds has been explained similarly. Comparable fossiliferous asphalt deposits elsewhere in California, such as Maricopa and McKittrick, have also yielded large quantities of carnivores, though apparently in lesser proportions than Rancho La Brea. Thus the overall percentage of carnivorous species in the Rancho La Brea assemblages does seem anomalously large, even for asphaltic deposits. The ongoing excavation in Pit 91, which retrieves all the preserved fossils and not just the larger and more spectacular ones, will help determine the extent of collecting bias during the earlier excavations in Hancock Park.



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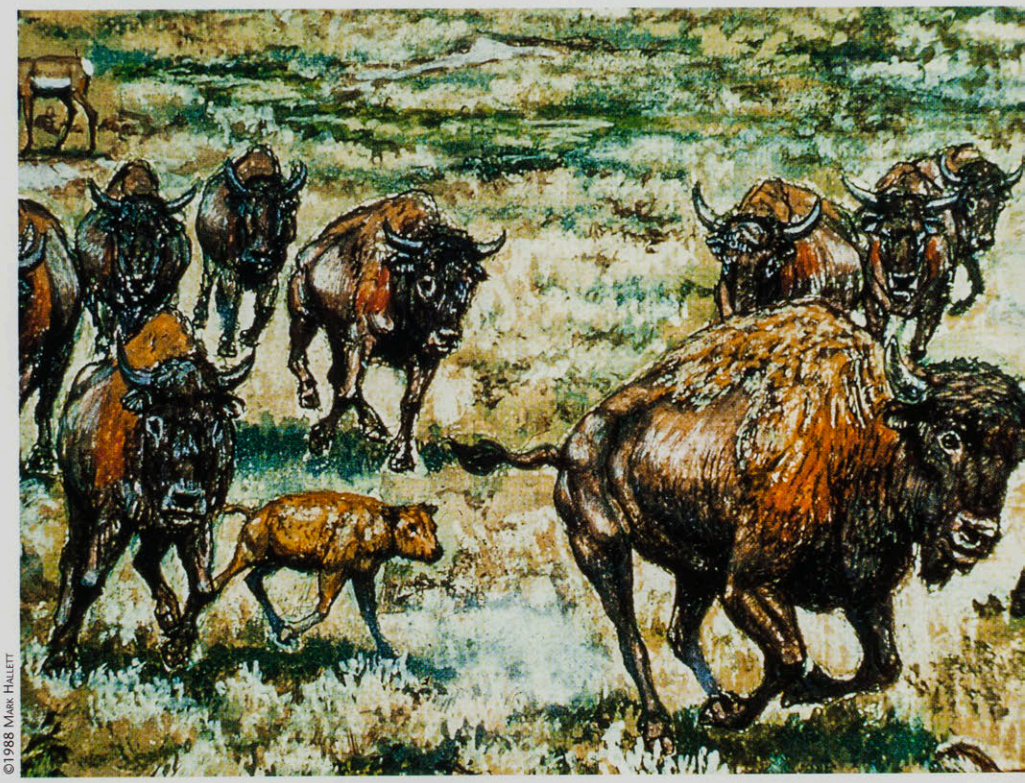
The extinct western camel, *Camelops hesternus*, stood seven feet tall at the shoulder; the presence of a hump is disputed.



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Although it is the most common large herbivore found in the Rancho La Brea biota, the extinct *Bison antiquus* was only present in the Los Angeles basin for two months each year.

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A La Brea Caracara *(Polyborus planca prelutosus)* feeds on the remains of a dire wolf.

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The occurrence of the western pond turtle, *Clemmys marmorata,* and other aquatic species in the Rancho La Brea deposits, indicates that streams were present for at least part of the year.

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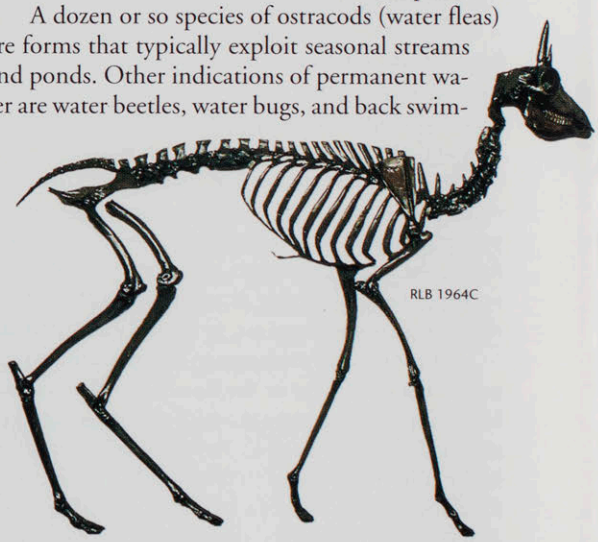
The Black-crowned Night Heron, *Nycticorax nycticorax,* was one of the rarest of a great variety of herons and egrets preserved in the asphaltic deposits.

AQUATIC LIFE

The presence of seasonal, if not permanent, water is indicated by the aquatic organisms from the asphaltic deposits. Aquatic plants include microscopic diatoms that typically occur elsewhere in springs, marshes, and shallow alkaline lakes; a variety of different species of pond weed, reeds, and bullrushes; and a number of trees and herbs that are normally associated with stream margins. Some of the stream margin flora, such as sycamore, alder, arroyo willow, and dogwood, are characteristic of mountain drainages, and their leaves and seeds may have washed downstream during times of flood before being preserved at Rancho La Brea. Others, such as the red cedar, elderberry, walnut, and live oak, would have more typically occurred at the fringes of the rivers and streams that crossed the coastal plain.

A dozen or so species of ostracods (water fleas) are forms that typically exploit seasonal streams and ponds. Other indications of permanent water are water beetles, water bugs, and back swimmers among the arthropods, five species of freshwater clams, and fifteen species of freshwater snails that suggest habitats varying from deep and well-oxygenated flowing water to shallow, stagnant ponds. Fish are represented by rainbow trout, arroyo chub, and sticklebacks; amphibians include several species of toads and frogs; and aquatic reptiles are represented by remains of garter snakes and the western pond turtle. The absence of aquatic mammals such as muskrats, and the relative rarity of the water-frequenting tapirs, appears to confirm the absence of large and permanent rivers from the immediate vicinity of Rancho La Brea.



Skeleton of extinct dwarf pronghorn *(Capromeryx minor).*

There is a great variety of waterfowl represented in the Rancho La Brea deposits. These include grebes, herons, egrets, swans, geese, and ducks. Most of the aquatic birds appear to be restricted to the later deposits (younger than 14,000 years), and many of them are known only from a single excavation site. *(Continued on page 18.)*

Old Wounds: The Paleopathology of Rancho La Brea

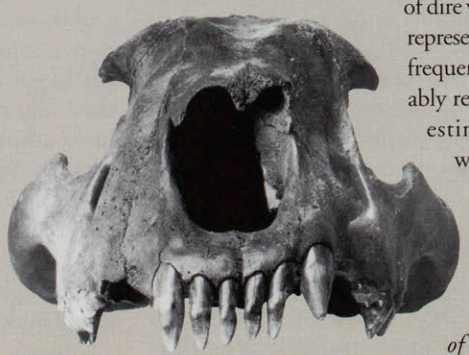
by Christopher A. Shaw

PATHOLOGY IS A BRANCH OF medicine that evaluates structural and functional changes caused by disease. The study of changes in bone and attached muscle due to disease or trauma is called osteopathology. Paleopathology ("ancient disease") is the study of disease and structural change that occurs in fossilized bones. Of the more than one million fossil bones from Rancho La Brea conserved in the collections at the Page Museum, about one percent display some kind of disease or trauma and are housed in a separate paleopathology collection. This collection includes 5,100 bones of the sabertoothed cat (*Smilodon*), 3,200 of dire wolf (*Canis dirus*) bones, and many skeletal elements of other animals (coyote, lion, bison, horse, sloths, camel, rodents, birds, etc.).

Fossil vertebrate remains usually consist of only one tissue (bone), the related soft anatomy (skin, muscles, glands, etc.) being lost prior to preservation. A diseased bone is often readily distinguishable from a healthy one, but it may be very difficult to diagnose the cause of the affliction. Different diseases that have different symptoms in the living animal, or that affect different soft tissues, may result in similar structural alterations of bony tissue. For example, comparable bony lesions may be produced by arthritis, hypervitaminosis A, and syphilis. However, some diseases leave behind physical and/or chemical clues which may be used to identify a cause or a general category of illness. Chemical analyses of fossil bones from Rancho La Brea are possible because the organic compounds within the bone have not been leached or altered by ground water or replaced through petrifaction.

The pathologic bones in the Rancho La Brea collection document five general categories of disease: developmental anomalies, dental problems, wounds, traumatic injuries, and chronic reinjuries. The first category is the rarest, and includes genetically initiated maladies that result in scoliosis (spinal curvature), mild spina bifida (cleft in the vertebral arch), abnormal fusion of adjacent bony parts or processes, or inadequate development of a body part. Typical dental problems seen in the collection include caries (tooth decay), impaction with and without infection, tooth loss, and tooth breakage with resorption of bone surrounding the tooth. Wounds and perforations affected many bones in the shoulder region and along the spinal column, causing osteomyelitis, and may represent bite wounds that became infected. There are hundreds of examples of traumatic injuries that include healed simple and compound fractures of limb and trunk elements, degenerative osteoarthritis, compression fractures in or fusion between vertebrae, and partial or complete dislocation of limb and trunk bones.

Chronic reinjuries are the most commonly recorded maladies. When muscles are stretched and strained to the point of injury, bony outgrowths are deposited to strengthen the area of muscular attachment to the bone, a condition known as osteophytosis. Over a long period of time, osteophytosis in chronically reinjured areas becomes quite extensive and massive. Because injuries of this sort were incurred and compounded while the afflicted animal was actively flexing and depressing its muscles, the large sample of chronic reinjuries in *Smilodon* and *Canis dirus* has helped paleontologists understand how these animals used their trunk and limbs to acquire prey.



RLB 3817.1

Massive trauma exhibited by some of the sabertoothed cat and dire wolf bones is so extensive that the afflicted animals were painfully crippled yet were able to survive months or years before death. Survival of severe trauma suggests that these extinct species lived in social orders that protected and nurtured drastically injured animals.

In the past, the asphalt traps at Rancho La Brea have been perceived as the ideal havens in which seriously injured large carnivores could survive by scavenging. However, the number of disabling injuries is really quite small in terms of the overall samples of dire wolves and sabertooths that are represented in the collections. The low frequency of osteopathologies probably represents a reasonably accurate estimate of disease and injury within the local populations.

Christopher A. Shaw is Collection Manager of the Rancho La Brea Department at the George C. Page Museum of La Brea Discoveries.

RLB 3991

Healed fracture of a *Smilodon* left radius compared to a normal bone. The massive bony growth surrounding the injury indicates a severe infection and the fracture caused shortening and bowing of the bone. This traumatically induced injury took a long time to heal and caused crippling of the limb.

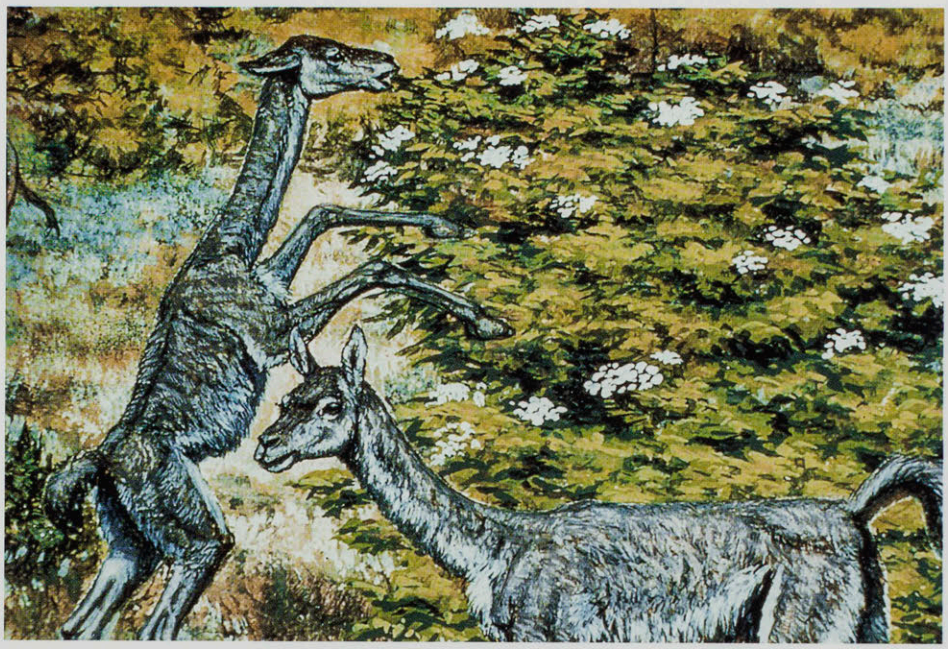
RLB 3826

ABOVE

The sixth neck vertebra of this giant ground sloth *Paramylodon harlani,* exhibits a degenerative form of osteoarthritis. The deep pitting indicates severe (and painful) fracture and degeneration of the cartilage disk after forceful compression of the neck vertebrae.

LEFT

Rotational stress caused the left canine to fracture in this *Smilodon* skull, and resulted in a large fragment of the canine being thrust into the nasal cavity. Early loss of this tooth has caused the facial bones to grow asymmetrically and the surviving left front teeth have shifted position.



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The long-headed, stilt-legged llama, *Hemiauchenia macrocephala*, was adapted for life in open grasslands, but was less common at Rancho La Brea than its larger relative, the western camel.

EVIDENCE FROM THE FOSSIL PLANTS

The fossil plants indicate that there were three distinct terrestrial habitats in addition to the aquatic and stream margin floras discussed above. Chaparral plants, conceivably washed in from the slopes of the Santa Monica mountains, include chamise, lilac, scrub oak, and manzanita. California juniper and digger pine could represent open and drier areas of this association, and coast live oak could have been present in the smaller canyons and on the lower slopes of deeper canyons.

A second association that may have grown in the larger, deeper, and more protected canyons is comprised of coastal redwood, California bay, and dogwood. This would appear to have been the southernmost prehistoric distribution of this group of plants, and their presence is almost certainly indicative of a cooler and perhaps wetter climate than that prevailing in the basin today. This interpretation is corroborated by the fossil land snails found in the Rancho La Brea deposits. Most of these species are today found in California and Arizona at elevations from 4,000 to 9,000 feet (1,300 to 3,000 meters) above sea level—further evidence of a cooler, moister climate at the time the asphaltic deposits were accumulating. Carbon 13 analyses of collagen from bone recovered at Rancho La Brea also suggest that summer temperatures were cooler than those of the present day.

A third plant group represents the antecedent of the modern coastal sage scrub association, which is dominated by small, drought-tolerant, woody bushes interspersed with herbs and seasonal grasses. During the Pleistocene, this association was dominated by coastal sage brush, black sage, and buckwheat, with patches of saltbush, tarweed, ragweed, thistle, morning glory, herbs, and grasses. Valley oaks were scattered at higher elevations on the alluvial fans; elsewhere closed cone pine groves consisting of Monterey pines, Monterey cypress, and juniper occurred sporadically over the landscape. It would seem that the majority of the larger herbivores represented at Rancho La Brea were exploiting this habitat.

EVIDENCE FROM SMALL AND LARGE MAMMALS

The environmental implications of terrestrial mammals from the fossil record must be viewed with caution because of potential sampling bias by the fossilizing agent. Most terrestrial fossils are preserved in lake or river sediments, and the resulting fossil assemblages are dominated by species that lived in or adjacent to permanent bodies of water or were otherwise water-dependent. Such samples may suggest that past environmental conditions were more humid than they actually were.

Many of the Rancho La Brea animals are believed to have been trapped initially by asphalt, invoking a different suite of biases (time of day or season of year when the asphalt was stickiest), but perhaps providing a more reliable estimate of the populations that lived on the Santa Monica plain. However, burial beneath stream deposits was still essential for preservation of the animals trapped by the asphalt. Indeed, there are instances that suggest that some fossils were initially buried by streamborne sediments and only later were impregnated by asphalt as it percolated upward through the stream deposits.

Rodent fossils are very useful for understanding the environments of the past because many rodent species normally occur only in specific habitats, and their remains are too fragile to be transported for long distances by streams. Because the earlier Rancho La Brea excavations concentrated on retrieving the larger and more spectacular mammals, our knowledge of the rodent fossils was, until recently, restricted to specimens that had been fortuitously preserved in the matrix stuck to bones of the larger animals or filling their braincases. The commonest species recovered in this manner was the southwestern pocket gopher, but pocket mice, kangaroo rats, ground squirrels, voles, grasshopper mice, harvest mice, and wood rats were also documented. Recently, considerable quantities of rodent material have been retrieved during the excavation at Pit 91, but much of this material has yet to be sorted under the microscope.

Nearly all of the rodent species represented in Rancho La Brea deposits are still living today, and most

are to be found in wooded or chaparral habitats. In contrast, many of the larger mammals appear to have been open-country forms. Further speculation on the environmental significance of the Rancho La Brea rodents must necessarily be deferred until they have been more intensively investigated.

The larger herbivorous mammals were probably less geographically restricted than were the rodents, but their relative abundance agrees with the habitats that have been inferred from fossil plant remains. The most common large herbivores are bison and horse, which were open-country grazers able to exploit the coastal sage scrub at least on a seasonal basis. Other open-country grazers or mixed feeders include camels, mammoths, and the Harlan's ground sloth. The dwarf pronghorn antelope found at Rancho La Brea was almost certainly an open-country species, as was the rarer flat-headed peccary. Browsing forms that might have preferred more closed or forest habitats, such as the Shasta ground sloth, mastodons, tapir, and deer, are much less common. Plant remains recovered from crevices in horse, bison, and camel teeth from Rancho La Brea are mostly leaf fragments from trees, shrubs and herbs, rather than grasses. Living bison and horses are predominantly grazers, but plant remains preserved in the teeth of their fossil relatives suggest that grasses were not abundant in the Los Angeles Basin toward the end of the Pleistocene.

The overwhelming preponderance of carnivores in the Rancho La Brea biota has already been mentioned. It may be environmentally significant that the dire wolf is the most common, for this species would have preferred open country in which to chase and capture its prey. Dire wolves far outnumber the sabertoothed cat or American lion, both of which probably preferred to stalk their prey from cover. It is interesting that the short-faced bear, the largest carnivore and the most common bear from Rancho La Brea, had relatively longer legs than the living black or grizzly bears—an adaptation that may have been useful in more open habitats.

Rodent fossils are very useful for understanding the environments of the past because many rodent species occur only in specific habitats, and rodent remains are too fragile to be transported for long distances by streams.

STUDIES OF ANIMAL DISTRIBUTIONS

To explain the diversity of fossil reptiles from Rancho La Brea, Bayard Brattstrom, Professor of Biology at California State University, Fullerton, concluded that there had been a transition in the Los Angeles Basin from a moist climate, typified by pine and cypress, through a stage of decreasing rainfall and a vegetation of coastal live oak and California juniper, to the present-day flora of oak woodland savanna and coastal sage scrub. An alternative interpretation would be that these plants were present in different parts of the basin throughout the same time. Further studies are needed, but some indication of a reduction in rainfall and/or cloud cover near the end of the Pleistocene is provided by the shrinkage and disappearance of many of the lakes that formerly dotted the landscape throughout California, Nevada, and Utah. Other evidence suggests that the Pleistocene landscapes were much more complex mosaics of woodland and steppe floras than might be predicted from the ecological zones of modern plants.

George Jefferson, former Associate Curator at the Page Museum, investigated the distribution of fossil mammals from the Pleistocene of southern California and identified three distinct associations. Horses and ground sloths were common at coastal sites; horses, llamas, and pronghorns were prevalent in intermontane basins; and camels predominated at sites in the Mojave Desert. Mammoth and bison were present in small numbers in all three regions. The Rancho La Brea fauna appears to constitute a variation of the coastal association: it has fewer camels than the desert group but more bison and ground sloths than the coastal or intermontane assemblages. Because of the nearby Santa Monica mountains, Rancho La Brea may have been more heavily wooded than other coastal sites; certainly the majority of the Rancho La Brea rodents appear to represent forest or chaparral habitats.

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The extinct dwarf pronghorn, *Capromeryx minor*, stood less than two feet tall at the shoulder.

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A western toad, *Bufo boreas halophilus*, captures a darkling ground beetle. Six different species of amphibians and 25 families of beetles are represented in the asphalt deposits.

THE EXTINCTION EVENT

The spectacular nature of the extinct larger animals from Rancho La Brea creates the impression that the Pleistocene fauna of the Los Angeles Basin was very different from that of today. However, such differences diminish markedly when the smaller animals are considered and when allowances have been made for the urban development in the basin during the present century.

Early investigators tended to seek, and perhaps overemphasize, minor differences between the anatomies of fossil animals and those of living species.

Early investigators tended to seek, and perhaps overemphasize, minor differences between the anatomies of fossil animals and those of living species, but such differences have not been upheld by more recent investigations. Nearly all of the more than 200 species of mollusks and arthropods recognized from Rancho La Brea are still living today, although a few are no longer found in the Los Angeles Basin. It is possible that some of the supposedly extinct arthropods and mollusks will be found surviving in northern Mexico when the biota from that country has been more intensively investigated.

Of the fish, amphibians, and reptiles, only one species (the largest toad) no longer survives today. Most of the birds that became extinct (21 of 138 species) were birds of prey or scavenging species. The only smaller mammals that became extinct at the end of the Pleistocene were the dwarf pronghorn and one species of mouse; otherwise, the extinct mammal species consist of the larger herbivores and the largest carnivores that preyed upon them. Not all of the genera that became extinct in North America were totally eradicated from the face of the Earth. The mammoths, mastodons, ground sloths, and sabertooths did indeed die out, but close relatives of the lions, horses, tapirs, camels, and llamas survived and flourished in other parts of the world.

Large mammals are inherently more vulnerable to environmental changes simply because they require a greater expanse of habitat in which to feed, reproduce, and defend themselves. Survival of the smaller Rancho La Brea animals suggests that they may have been less affected than the larger species by climatic changes at the end of the Pleistocene. It is possible that, requiring less space and with different reproductive strategies, they were better able to respond individually to reduction or shifting of their habitat.

Many scientists believe that some kind of worldwide catastrophic event took place at the end of the Pleistocene, resulting in the extinction of many large mammals and reduction in the geographic ranges of others. This process led to the extinction of 40 percent (24 species) of the mammals preserved in the Rancho La Brea deposits, including the numerically abundant larger carnivores and many of the common medium- to large-sized herbivores. The approximate timing of this event is known from radiometric analysis, and it appears that extinction of the mammals took only a few thousand years and concluded about 11,000 years ago.

The possible causes of this extinction event have been extensively debated during the past decade, and three major explanations have been offered: human agency, environmental change, and a combination of the two. Proponents of the "human overkill" hypothesis directly link the arrival of humans in the New World with the decline of the indigenous large animals. Proponents of ecological hypotheses focus on the large-scale climatic and habitat changes that must have occurred toward the end of the Wisconsinan glaciation.

Although the end of the Pleistocene was a time of turnover or extinction for the larger herbivores and the large carnivores that preyed upon them, 60 percent of the mammalian species represented by fossils at Rancho La Brea survived the extinction event. Some of the survivors, such as the gray wolf, cougar, pronghorn, and deer, then assumed a more prominent role in the North American faunas. And some of the species that became extinct were replaced by direct descendants (the ancient bison) or by near relatives (the flat-headed peccary). The roles of ground sloths, mammoths, mastodons, horses, tapirs,

camels, and llamas were not directly filled by close relatives but by ecologically equivalent ruminants, particularly deer and pronghorn, that had been present but less common before the extinction event.

It is intriguing that most of the Pleistocene herbivore species that survived possessed a different kind of digestive mechanism than those that became extinct, a fact that seems to favor an ecological rather than anthropological cause of the extinctions.

Herbivorous mammals are incapable of directly digesting cellulose (the major constituent of plant material), and rely on bacteria in their digestive tract to break plant matter down into products that can be assimilated. Several different strategies were developed by herbivores to provide a "fermentation tank" in which such bacterial processing could take place. In some, the caecum and colon of the hind gut became enlarged; these animals are thus known as hind-gut fermenters.

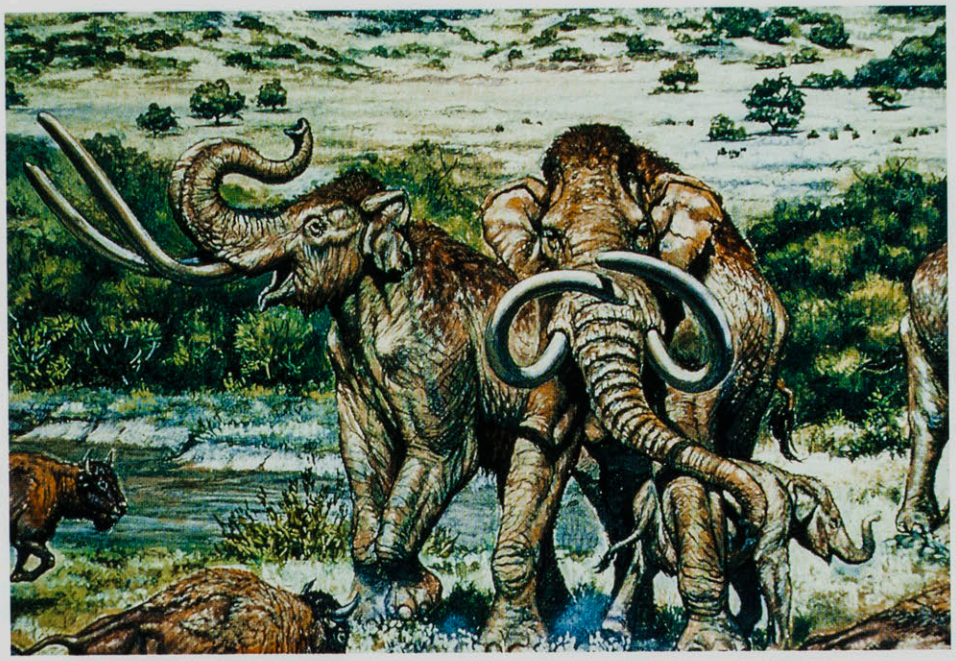
Ruminants, in contrast, evolved a multichambered stomach. Their food, after being swallowed, is initially stored in the first chamber of the stomach (the rumen—hence the term "ruminant"), in which bacterial fermentation starts. The partially fermented plant material is later regurgitated to be chewed again, and is then passed through the remaining stomach chambers, where additional fermentation takes place. Hind-gut fermenters do well when large quantities of high-fiber, low-quality food are available. The ruminant stomach is more efficient, conserving water and allowing a greater proportion of food to be used by its owner, but the digestive process is considerably slower.

Most grazing herbivores tend to be mammals of large size, mainly hind-gut fermenters (such as the Rancho La Brea horses and mammoths), although they also include some large ruminants such as bison. Those that eat low-lying herbs are typically small- to medium-sized ruminants such as the pronghorn. Among the browsing species recovered from Rancho La Brea, the mastodons, Shasta ground sloths, and tapirs represent hind-gut fermenters, whereas the deer are ruminants; the chambered stomach of camels and llamas is less well developed than that of other ruminants, and the omnivorous peccaries are hind-gut fermenters. The mammals that survived were either the more efficient ruminating forms (bison, deer, pronghorns) or omnivores like the peccary that had a broad dietary range. Those that became extinct were mainly the less efficient hind-gut fermenters but included camels and llamas, which are among the least efficient ruminants.

Late Pleistocene climatic changes accelerated the trend toward more strongly defined seasons, which decreased the mosaic diversity of plant communities and increased their zonation. The shorter growing seasons of more northerly latitudes decreased the quality and quantity of food available to large mammalian herbivores. Particularly hard hit were the mastodons, mammoths, ground sloths, and horses—hind-gut fermenters adapted to take advantage of the mosaic vegetation of the Pleistocene plains. Also drastically affected were their predators, the larger carnivores. It is interesting that the only extinct insects from Rancho La Brea are two scarab beetles that would have been dependent on plentiful supplies of mammal dung for their life cycles. Their extinction might have coincided with that of the late Pleistocene ungulates.

Late Pleistocene extinctions took place throughout the world but were evidently more drastic at higher latitudes. Some formerly widespread kinds of mammals (lions, proboscideans, tapirs, horses, camels) still persist at lower latitudes where annual growth seasons are comparatively long. It is, of course, entirely possible that the arrival of skillful human hunters in the New World at a time of rapid, wide-sweeping environmental change contributed to the ecological stress experienced by the larger mammalian herbivores by adding an additional member to the carnivore guild. In this way, humans may have played a significant though perhaps not pivotal role in the demise of the late Pleistocene megafauna. Feral horses and asses, reintroduced to North America in historic times, now survive successfully in the wild as might close relatives of the other extinct herbivores were the continent less widely affected by human settlement.

Dr. John M. Harris is Chief Curator and head of Vertebrate Programs at the Natural History Museum.



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Most Rancho La Brea specimens of the Columbian mammoth *(Mammuthus columbi)*, are from horizons in Pit 9 that could be up to 40,000 years old. The scarcity of mammoths from other, younger levels may be because only the seep at Pit 9 provided the right combination of circumstances for trapping and preserving the remains of these large mammals.

A New View of an Ancient Landscape

by George T. Jefferson

The new image of Rancho La Brea that is emerging is most evident from a comparison of the two most famous Rancho La Brea murals, *Rancho La Brea* by Charles Knight, painted in 1925, and *Treasures of the Tar Pits,* painted by Mark Hallett in 1988. Advances in our understanding of the biologic diversity of Rancho La Brea have allowed Hallett to make a more detailed and accurate reconstruction of the prehistoric environment than was possible in Knight's time.

Even though both artists viewed the prehistoric scene from the same direction (north towards Cahuenga Pass), there are major differences. The Hallett mural depicts Rancho La Brea early in the afternoon on a late spring day about 20,000 years ago. The asphalt trap in the foreground is seen not as an open liquid pool but as a dust-covered seep. Coastal sage scrub plants, sycamores and oaks at the border of a stream, local groves of cypress and pine, and a fresh water pond have replaced the open grassland savanna of Knight's image.

The cast of characters has grown from a dozen large animals to over 130 species (625 are now known from Rancho La Brea). Smaller animals—bees, butterflies and snails, toads, turtles and lizards— now populate the foreground. Although the new view is overcrowded (an unavoidable result of showing as many plants and animals as possible), the animals occupy particular habitats, and behavior such as prey capture method, feeding posture, and herd or pack size are shown. As fitting the spring season, plants are in bloom and juvenile animals are present.

Most noticeable are the new reconstructions of some of the mammals. Not only is morphology better understood, as seen in the revised shape of the head in the ground sloth (*Paramylodon harlani*), but also coat colors have been reinterpreted. The extinct western horse was related to zebras, and in the past it has been illustrated with stripes and without. The present rendition is a colorful blend of the pattern seen in the extinct African quagga and living zebras. The California sabertooth cat has traditionally been illustrated with a monotone light brown or yellow brown coat. However, some researchers believe a spotted coat is more correct. Recent anatomical studies suggest that this animal ambushed its prey: under these circumstances, a camouflaged pattern is advantageous, and many living cats that hunt from cover have spotted, striped or marbled coats.

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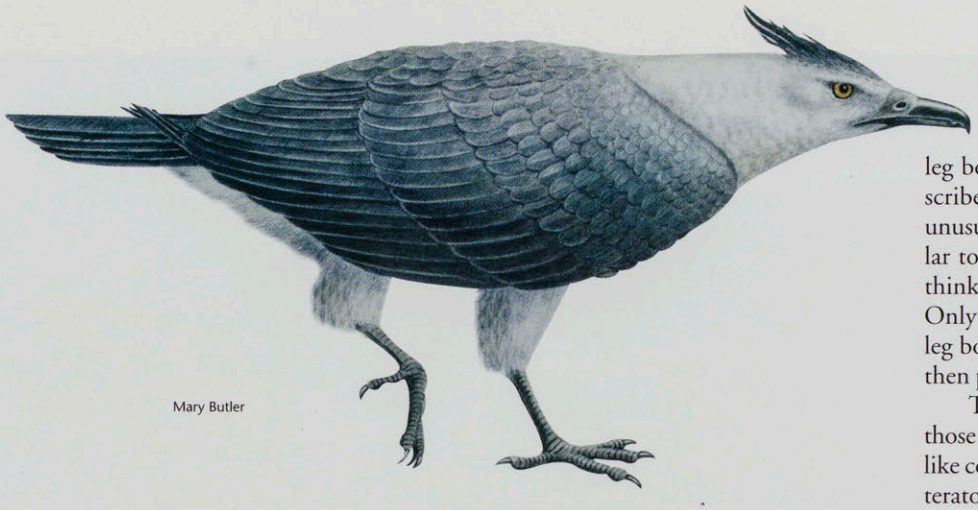
Rancho La Brea mural by Mark Hallett, commissioned for the traveling exhibition "Treasures of the Tar Pits" in 1988.

Rancho La Brea mural by Charles R. Knight, commissioned by the Los Angeles County Museum of History, Science and Art in 1925.

The Teratorns

by Kenneth E. Campbell, Jr.



Mary Butler

Merriam's Teratorn had a wingspan of 14 feet but stalked its prey from the ground. Like all ground-stalking birds, it would have had a light-colored head, which would have blended with the sky and made it less obvious to its prey. A different restoration of teratorns is seen in the Hallett mural, page 23. There, a darker colored teratorn is seen stalking several turkeys (lower right corner).

Crania of Merriam's Teratorn, *Teratornis merriami,* (below), and of the extinct ancestor of the California Condor, *Gymnogyps amplus,* above. The difference in the jaw action of the two birds indicates that teratorns did not feed in the same manner as vultures or condors.

RLB 971

RLB 300

THE FIRST EXTINCT FOSSIL BIRD DISCOVERED AT Rancho La Brea was the teratorn, *Teratornis merriami,* which was described in 1909. Since that time teratorns have been found across the southern United States to Florida and into South America. But they are best known from Rancho La Brea, where over 100 individuals are represented in the collections.

Teratorns attract a lot of attention because they were big, the largest birds to be entrapped at Rancho La Brea. They had a wingspan estimated at over 10.5 feet (3.2 meters) and they weighed about 31 pounds (14 kg). Because these birds were extinct, with no living relatives, interpreting what kinds of birds they were depended upon studies of their bones. Fortunately, there are plenty of teratorn bones from Rancho La Brea.

When the first bones of teratorns—skulls and the breast bones—were found, researchers realized that they were from a bird dramatically different from any that they had seen before and teratorns were placed into their own genus. Shortly thereafter some large, unusual leg bones were discovered, and they, too, were described in their own genus because they were so unusual. These latter bones, however, were very similar to those of condors, and this led researchers to think that they represented a new species of condor. Only later was it realized that the head bones and leg bones were from the same bird. Teratorns were then placed into their own family, in a single genus.

The similarity of teratorn hindlimb bones to those of condors led to the assumption that teratorns, like condors, were scavengers. And for over 70 years, teratorns were depicted in literature and illustrations as a type of condor, right down to having naked heads and necks and hanging around animals stuck in the tar waiting for them to die.

In the early 1980s, however, new studies of teratorns revealed that they could not have fed like condors because of the structure of their skulls. Teratorns had some eagle-like features, the foremost of which was a large, hooked beak, and their jaws simply did not work like the jaws of condors. Birds with jaws structured like those of teratorns are active predators that capture small, live prey. Because teratorns were very heavy bodied and had short legs, they could not run after prey animals, so they must have captured their prey by stalking. With their specially adapted jaws they then would have swallowed their prey—including small mammals, birds, frogs, and lizards—whole. An abundant food source would have been the young chicks of the extinct California Turkey. Teratorns may also have been opportunistic scavengers, but because of how their jaws worked they would have been limited to scavenging the bodies of small animals.

With this new interpretation of the feeding habits of teratorns comes a new interpretation of what they looked like. The wing and hindlimb morphology of teratorns is still considered to be very similar to that of condors; therefore, the shape of the wings and their mode of flight are also considered. Because of their large size, and especially the spread of their wings, teratorns were necessarily limited to living in more open countryside. In wooded or brushy areas they would not have been able to open their wings.

Vultures have naked heads because they often stick their heads into the rotting carcasses of dead animals, where feathers would become soaked and matted together. Instead of black, naked-headed scavengers, teratorns were probably light-colored birds with a fully feathered head.

Dr. Kenneth E. Campbell, Jr. is Curator of Ornithology at the Natural History Museum.

The Short-faced Bear

by Shelley M. Cox

RLB 2039

Restoration of the head of the short-faced bear, *Arctodus simus*, by Charles R. Knight under the direction of John C. Merriam and Chester Stock, published in 1925.

THE EXTINCT GIANT SHORT-FACED BEAR *(Arctodus simus)* is the largest and most common member of the bear family recovered from the asphalt deposits at Rancho La Brea. Remains of at least 30 individuals have been documented so far. Bones of black bears *(Ursus americanus)* and grizzly bears *(U. arctos)* have also been found, but in fewer numbers. Grizzly bear remains are known only from the youngest Rancho La Brea deposits, as this animal did not enter the contiguous United States until near the end of the last Ice Age.

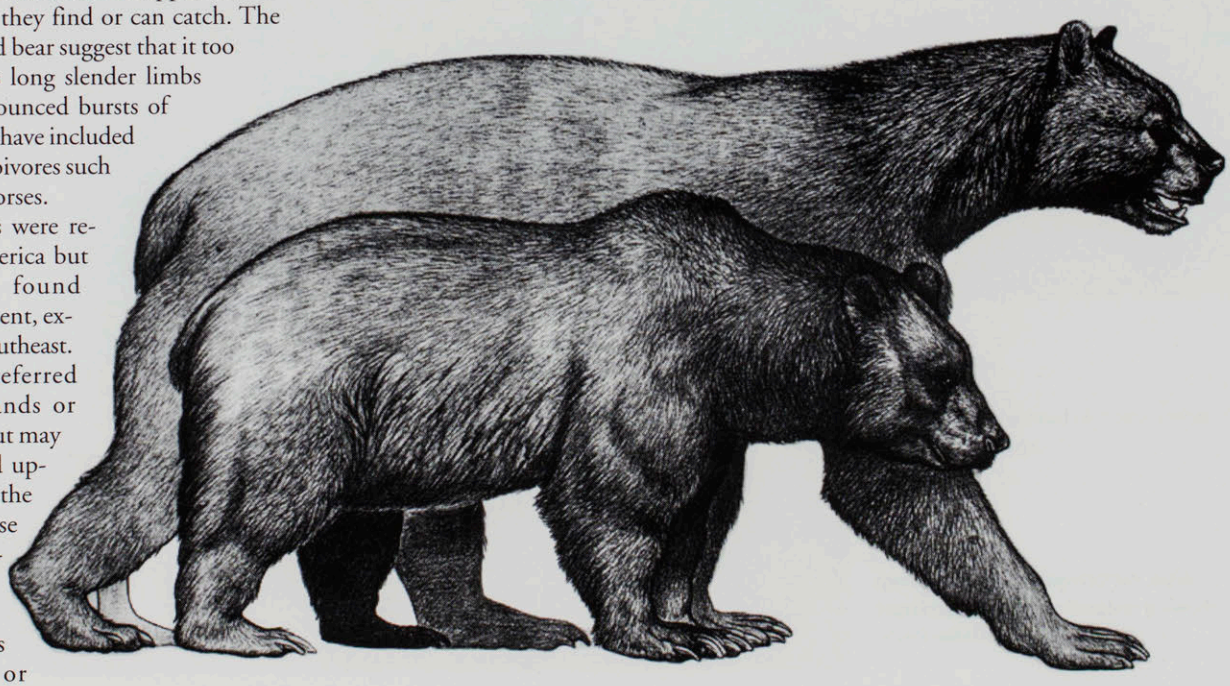
A full-grown, adult short-faced bear was the largest and most powerful predator of the late Pleistocene in North America, although it was more slenderly built than the living bears. Males weighed between 1,500 and 1,800 pounds (680 to 818 kg), and stood five feet tall (1.5 m) at the shoulder; females were about 25 percent smaller and lighter. Rearing up on their hind legs, male short-faced bears would have stood 11 feet tall (3.3 m). In contrast, the largest grizzlies may reach a height of 10 feet (3 m) when standing erect, and weigh about 1,400 pounds (635 kg) before hibernation in the fall.

The short-faced bear's head was very wide, with a short, broad muzzle that made it look more like a cat than a bear. Its canine teeth were large and widely set, and the single meat-shearing tooth in each jaw was better developed than in the grizzly. Otherwise its mouth contained the typical mixed dentition of a omnivorous bear—spiked teeth capable of cutting flesh and flatter grinding teeth for chewing leaves and fruit. Whereas black bears are mainly vegetarians, and have low-crowned grinding teeth, grizzly or brown bears are opportunistic and will eat whatever they find or can catch. The teeth of the short-faced bear suggest that it too was opportunistic. Its long slender limbs were capable of pronounced bursts of speed, and its diet may have included the young of large herbivores such as bison, camels, or horses.

Short-faced bears were restricted to North America but their remains are found throughout the continent, except for the extreme southeast. They apparently preferred well-drained grasslands or other open country, but may have occupied rugged uplands or caves during the denning season. These habitats are now occupied by grizzly bears, but we do not know if the grizzly ousted its larger competitor or merely occupied the habitats left vacant after the short-faced bear died out.

Current research indicates that short-faced bears became extinct toward the end of the last Ice Age, approximately 11,000 years ago. The causes of its extinction, like those of other large Late Pleistocene carnivores, have yet to be resolved. The quantity and quality of short-faced bear fossils preserved at Rancho La Brea provide a unique opportunity to learn more about one of the most unusual predators of the late Pleistocene.

Shelley M. Cox is Laboratory Supervisor in the Rancho La Brea Department at the Page Museum.



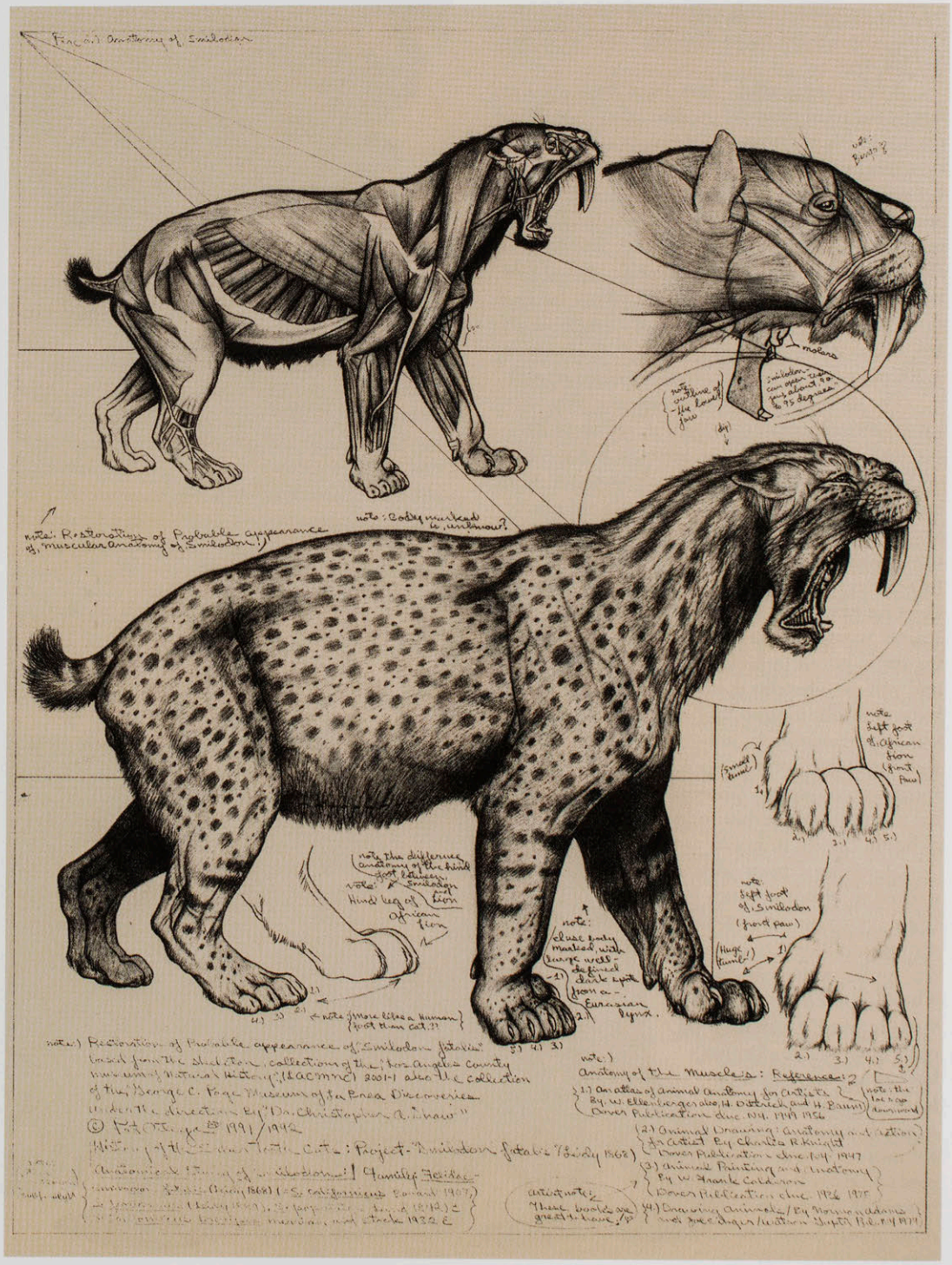
Short-faced bear compared to smaller grizzly bear, by Pat Ortega.

The Sabertoothed Cats

by Christopher A. Shaw

THE MOST UNUSUAL OF THE EIGHT KINDS OF cats known from Rancho La Brea are the sabertooths, which are represented by two species. The scimitar cat, *Homotherium serum*, is known only from three teeth and five foot bones from Rancho La Brea. In contrast, the sample of the sabertoothed cat, *Smilodon fatalis*, numbers around 166,000 bones. *Homotherium* was much less common than *Smilodon* across North America, but each had a wide geographic distribution.

The sabers of the scimitar cat were relatively short, very flattened and recurved, with serrations on both edges. The lower jaw had a moderately developed flange (or "chin"), which presumably protected the sabers when the mouth was closed. The cat's head was apparently carried high on a long neck;


note: Restoration of probable appearance of musculature & anatomy of Smilodon
note: Body marked as in mouse?
note the difference anatomy of the hind foot between Smilodon & Hind leg of African lion
note: Cloaca cavity marked with large well-developed dark spot from a Eurasian tiger.
note: left foot of African lion (front paw)
note: left foot of S. Smilodon (front paw)
note: more like a human foot than cat?
Anatomy of the Muscles: References
(1) An atlas of Animal Anatomy for Artists By W. Ellenberger, also H. Dittrich, and H. Baum. Dover Publication Inc. NY. 1949 1956
(2) Animal Drawing: Anatomy and Action for Artist By Charles R. Knight Dover Publication Inc. NY. 1947
(3) Animal Painting and Anatomy By W. Frank Calderon Dover Publications Inc. NY. 1935
(4) Drawing Animals By Norman Adams Watson-Guptill Pub. NY. 1977

Artist Pat Ortega's working drawings showing restoration of the musculature and pelt of *Smilodon fatalis*.

its forelimbs were long, but its hindlimbs were relatively short, and its back sloped like a hyena's. *Homotherium* and *Smilodon* both had a bobbed tail, in contrast to large living cats. But *Smilodon's* sabers were enormous recurved structures that were less flattened and possessed finer serrations than those of *Homotherium*. In addition, the flange on the lower jaw was small and offered little protection for the sabers. The fore- and hindlimbs were about the same length, but stout and heavily muscled. The claws of *Smilodon* were retractable and important tools for grasping and holding prey when the long sabers punctured the victim's hide. Studies of the bones in the throat that anchor the tongue indicate that this species could roar like a lion.

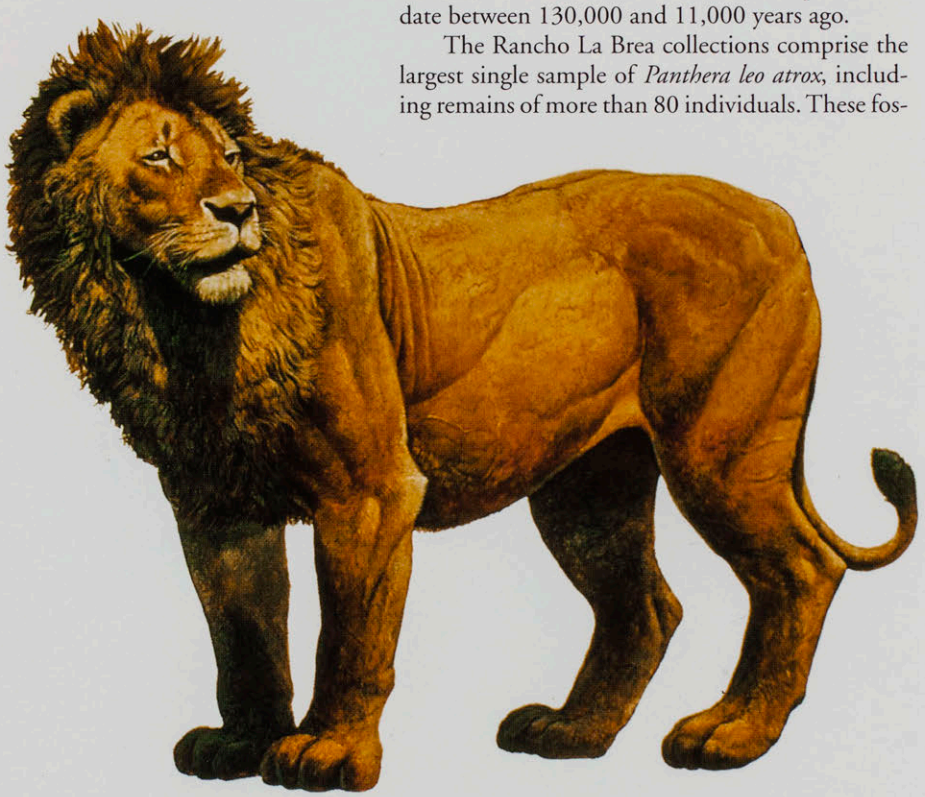
Because of the exceptionally large sample of *Smilodon* from Rancho La Brea, we have learned a great deal about the structure and habits of this extinct carnivore. It was about the same size and weight as an African lion; however, the body proportions were different from those of any large living cat. Its robust front limbs indicate that it sought prey that greatly exceeded its own weight, but its skeletal structure suggests that it did not chase its prey extensively. This animal was an active predator that relied on stealth and ambush rather than speed, using surprise and a short rapid pursuit, followed by a violent impact and a lethal bite.

The remains of adult, subadult and cub individuals of *Homotherium* (probably representing a family group) were found in a Texas cave, where they had apparently been crushed by the collapse of the cave's roof. In the same sediments, hundreds of remains of juvenile mammoths and mastodons—evidently the preferred food of *Homotherium*—were found. There is no direct evidence that *Smilodon* preyed upon pachyderms, but its teeth and skeletal structure were ideal for attacking these and other large, thick-skinned animals like ground sloths. In addition, it is apparent that *Homotherium* sought caves and similar shelters as denning sites, whereas remains of *Smilodon* are rarely found preserved in caves. *Smilodon* probably preferred wooded areas with substantial brushy undergrowth as denning sites. Social behavior in *Smilodon* may be inferred from examples of healed injuries within the paleopathologic collection. There are many impressive examples of crippling traumatic injuries. These are so severe that the animal would have been incapacitated for many months, yet most of these bones exhibit extensive healing. The survival of severely injured individuals of *Smilodon* clearly implies some sort of group social existence that allowed injured members to feed at kills and gave them some protection from other predators. In addition, African lions are occasionally injured by others in the pride while feeding at kills, and in fights between males for pride dominance. Many bone lesions that are found in the shoulder region and along the spinal column of *Smilodon* are reminiscent of infected bite wounds, and may have resulted from similar interactions.

Restoration of the head of *Homotherium serum* by Pat Ortega.

The American Lion

by George T. Jefferson



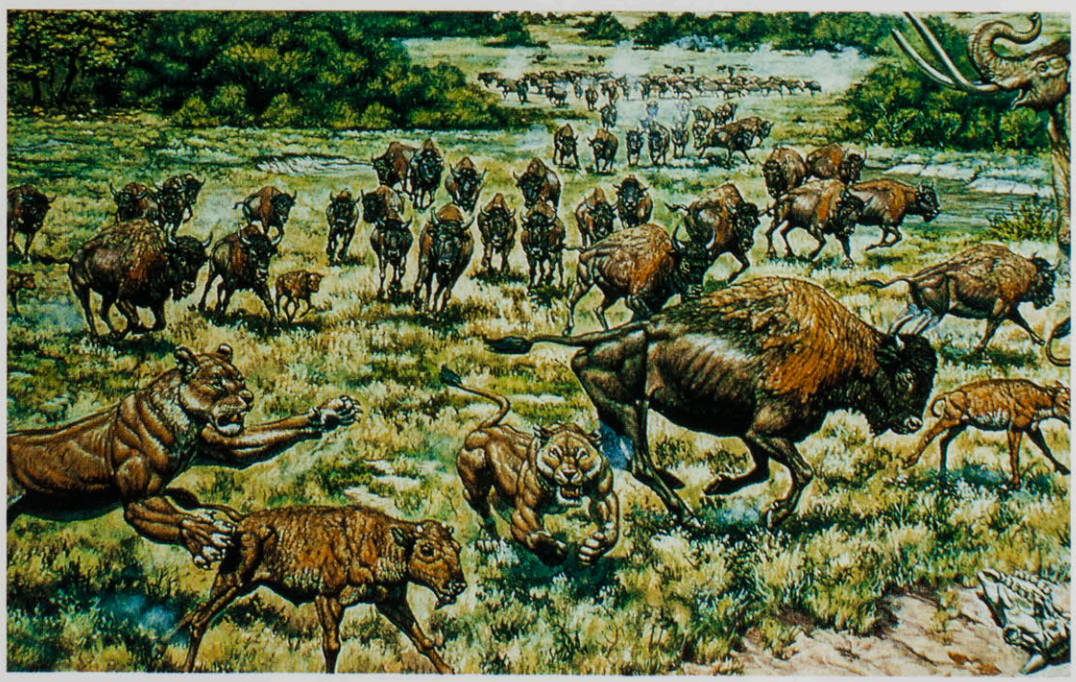
American lion by John C. Dawson.

The American lion, *Panthera leo atrox*, is closely related to the extinct cave lion of Europe and Asia, *P. l. spelaea*, and the living African lion, *P. l. leo*. The geographic distribution of the American lion extended from southernmost western Canada through the U.S. and Mexico, and its remains have been recovered from deposits that date between 130,000 and 11,000 years ago.

The Rancho La Brea collections comprise the largest single sample of *Panthera leo atrox*, including remains of more than 80 individuals. These fossils provide a unique opportunity to make comparisons of body size and population structure between the American lion and the living African lion. The two animals are osteologically very similar but are placed in different subspecies. The American lion is about 10 percent larger than the contemporaneous Eurasian cave lion and about 25 percent larger than the living African lion. As in living lions and tigers, American lion males were larger than females.

In African lions, the association of large males with more numerous, smaller females is believed to be related to pride structure and to hunting strategy that results in higher male mortality. Modern lion populations of East Africa have a male:female ratio of about 74:100; pride behavior in these lions directly favors the survival of females. Paleolithic illustrations of cave lions from Europe consistently show small groups of animals with reduced manes. Small pride size in cave lions is thought to be related to a limited supply of food because, in African lions, prides are small and mane size is reduced when food supplies are limited.

The male:female ratio observed in the Rancho La Brea population of *Panthera leo atrox* is 128:100. The larger number of males suggests that American lions did not live in African lionlike prides but hunted in pairs or alone. This in turn suggests that pride behavior and cooperative hunting in large cats may be restricted to the African lion. The development of pride behavior, which may have been a response to the appearance of open environments in Africa, apparently post-dates the spread of *Panthera* across Eurasia and into North America.



American lion hunting ancient bison; vignette from Hallett mural.

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The Dire Wolf

by Christopher A. Shaw

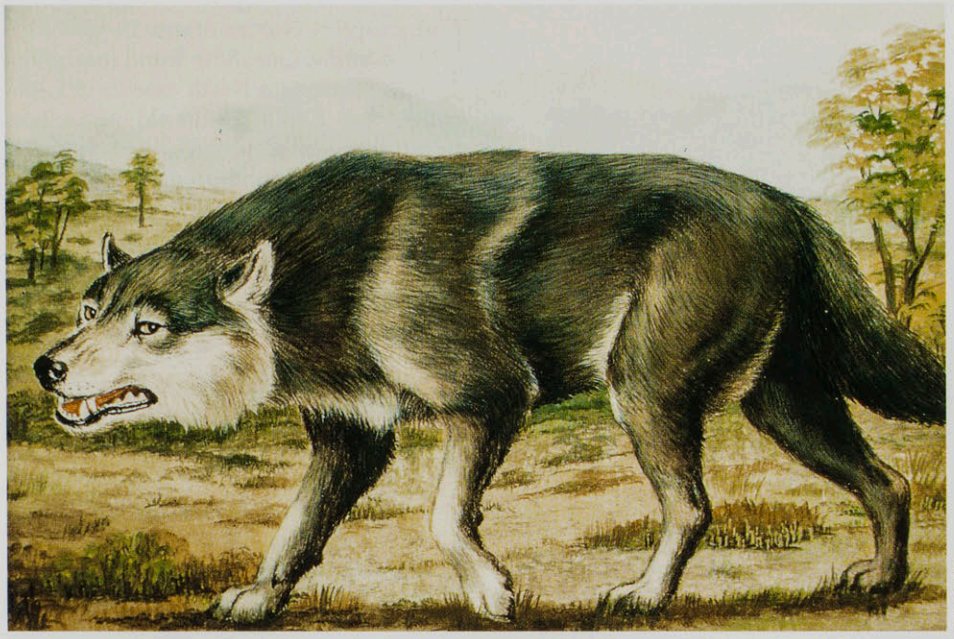
FIVE SPECIES OF THE DOG FAMILY (CANIDAE) ARE represented at Rancho La Brea: the extinct dire wolf (*Canis dirus*), gray (or timber) wolf (*C. lupus*), coyote (*C. latrans*), two varieties of domestic dog (*C. familiaris*) and the gray fox (*Urocyon cinereoargenteus*). The timber wolf, coyote and fox survive as extant species, and the two domestic dogs are well known native American mongrel varieties (the coyote-sized "Plains-Indian" dog and the smaller, slender-nosed "Techichi"). The dire wolf, the only extinct canid, is represented by more than 200,000 specimens, making it by far the most abundant species in the Rancho La Brea biota.

Dire wolves may have originated in South America but became dispersed throughout Central and North America by about 130,000 years ago and were the dominant carnivores in the New World during the latter half of the Pleistocene. Two distinct populations (or subspecies) of *Canis dirus* are recognized from North America; the population found west of the Rocky Mountains and in Mexico was up to 15 percent smaller than that of the eastern-central United States.

The dire wolf was similar in size to the gray wolf but was more heavily built, with a deeper chest and more massive hips but shorter, stouter limbs. In addition, its skull was larger and broader, and it had bigger teeth but a smaller brain, than that of the gray wolf.

Because of their shorter legs, dire wolves were probably not as fleet of foot as gray wolves. However, they formed packs of considerable size, perhaps exceeding 25 animals, and hunted prey cooperatively. Their powerful jaws were well suited to pulling down large animals, like bison or camels, and were capable of crushing large bones. In fact, some paleontologists have suggested that dire wolves played a role similar to African hyenas, which use cooperative chasing by different members of the group to run down their prey, rather than stalking and pouncing. It is evident that these wolves also ate carrion.

Dire wolf bones from Rancho La Brea display many examples of severe traumatic injuries (such as dislocations and fractures) that subsequently healed. This suggests that incapacitated members of the pack were nurtured and protected from other predators during the long healing process. Crushed paws, and healed fractures to the head, limbs, and trunk are similar to injuries incurred by modern gray wolves in pursuit of large prey animals like moose. It is noteworthy that the typical dire wolf injuries are different from those of sabertoothed cats (the second commonest predator from Rancho La Brea), and indicate that these two animals used totally different methods of prey capture.

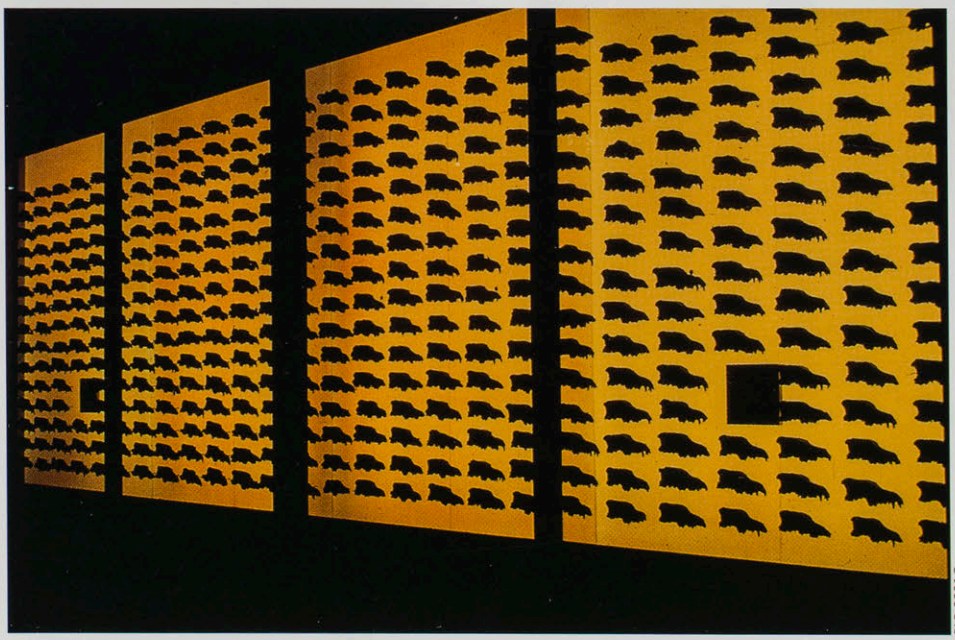


RLB 3186C

Canis dirus by Mary Butler

RLB B-758

Restoration of dire wolf by Herman Beck. Original in the Page Museum.



RLB 2281C

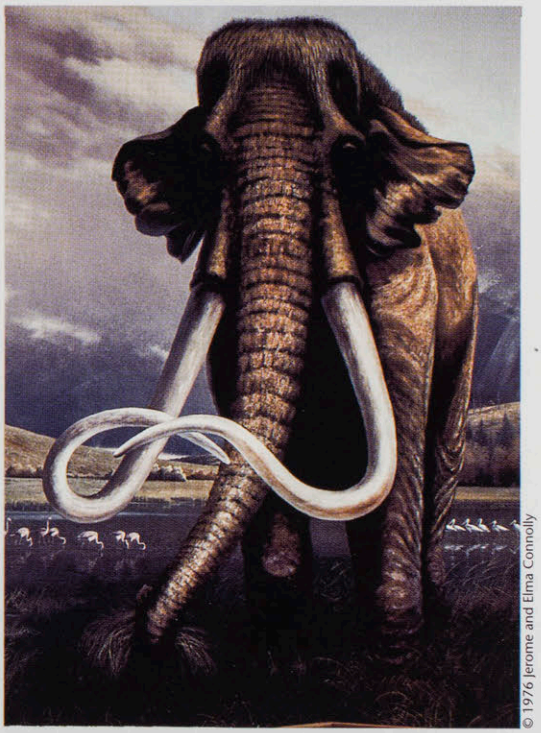
Display of 404 dire wolf skulls at the Page Museum.

Mammoths and Mastodons

by John M. Harris

RLB 2071C

Columbian mammoth skeleton in the Page Museum with John Haan, Mr. Page's adopted son, for scale.



© 1976 Jerome and Elma Connolly

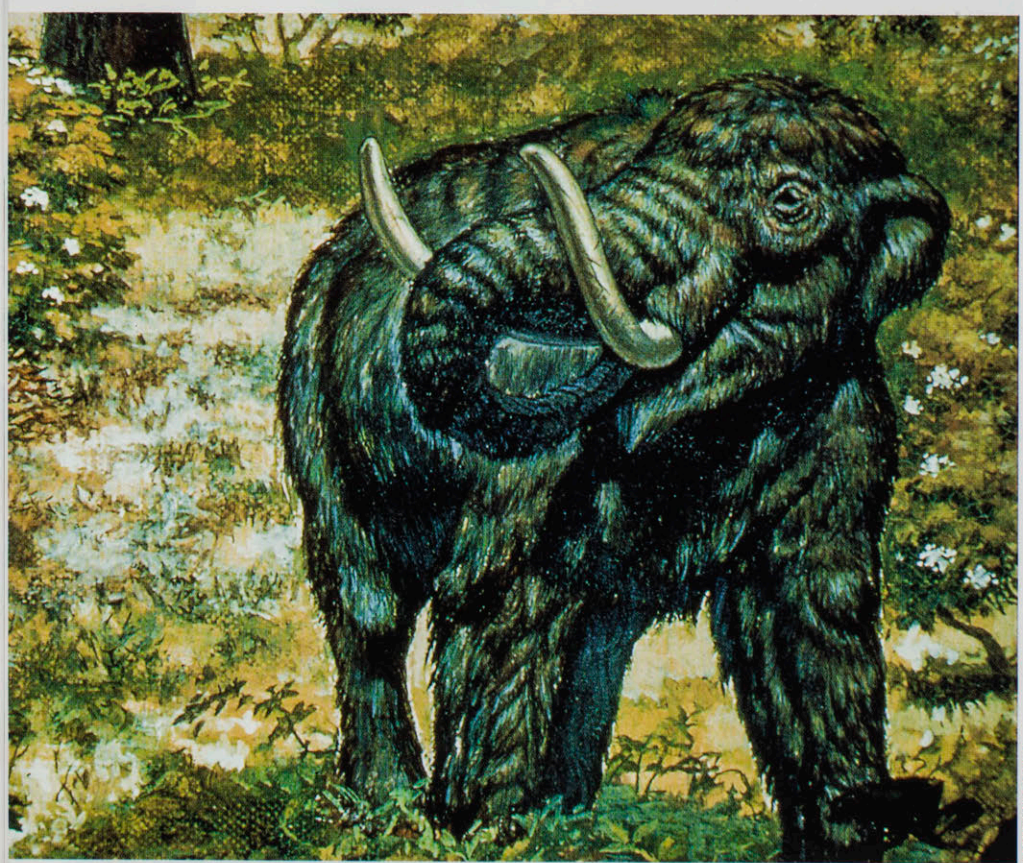
Restoration of the Columbian mammoth from the mural painted by Jerome and Elma Connolly for the Page Museum.

The common North American mammoth (*Mammuthus columbi*) is found throughout much of southern North America at localities younger than 2 million years old but includes specimens that are sometimes interpreted as four different species—Columbian mammoth, imperial mammoth (*M. imperator*), Jefferson's mammoth (*M. jeffersonii*), and the dwarf mammoth (*M. exilis*).

Columbian mammoths have been found at several different localities in southern California. Remains of more than 35 individuals have been recovered from the Rancho La Brea asphalt deposits, most of them from the excavation of Pit 9 in 1913. The Rancho La Brea specimens were about the size of an African elephant; adult males would have stood 12 to 13 feet tall (3.7 to 4 m) at the shoulder and would have weighed 8,000 to 10,000 pounds (3629 to 4536 kg). Although the mammoths from Pit 9 include both very young and very elderly individuals, most were young adult males (30 to 40 years old at the time of death), an age estimate based on the state of wear of the teeth and the degree of fusion of the femurs (thigh bones).

Why mammoths were found almost exclusively in Pit 9 (a few individuals are known from an earlier excavation by the Southern California Academy of Sciences) still eludes explanation. Perhaps these were the only two localities where conditions were such that mammoths could become trapped by the seeping asphalt. Or perhaps mammoths were present only in the Los Angeles Basin for a short span of time and these were the only seeps active at that time. Unfortunately, no reliable bone dates have yet been obtained for the Pit 9 fossil assemblage, but dates from fossil wood suggest an age of up to 40,000 years.

Restoration of American mastodon.



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Also originating in Africa, the more primitive proboscideans known as gomphotheres and mastodons arrived in North America about 8 million years before mammoths. Some gomphotheres had both upper and lower tusks but mastodons, like mammoths, had only upper tusks. Mastodons were smaller than mammoths and had low-crowned teeth for browsing on leaves and shrubs. All of the permanent mastodon teeth could be present in the jaw at the same time whereas mammoths, like elephants, never have more than two teeth at a time erupted in each half jaw. The last surviving mastodon species, the American mastodon (*Mammut americanum*), was widespread in North America during the Late Pleistocene and has been recovered from many of the Rancho La Brea excavations. Curiously, specimens of the American mastodon from Rancho La Brea seem to be smaller than those found elsewhere in the country.

The Horses of Rancho La Brea

by Eric Scott

EXTINCT HORSES ARE AMONG THE MORE abundant large herbivores from Rancho La Brea and are exceeded in number only by bison. Two species of extinct horse have been identified. The common species, and larger of the two, was named *Equus occidentalis* (the "western horse") although the validity of this name has been challenged. A second, smaller species, *E. conversidens* (the Mexican "ass"), is represented by three individuals. Both species and their native North American kin died out near the end of the Pleistocene Epoch, approximately 11,000 years ago.

More than 220 individuals of *Equus occidentalis* are represented at Rancho La Brea. The western horse would have stood approximately 14.5 hands (4 feet 10 inches/1.46 m) high at the shoulder, and probably weighed about 1,150 pounds (680 kg). The skull was large relative to the animal's body size, and the body was heavily constructed—more like a burly Clydesdale than an Arabian saddle horse. The skeleton of *E. occidentalis* bears a strong resemblance to those of the modern East African plains zebra (*E. burchelli*) and the extinct South African quagga (*E. quagga*). It is considered likely by many scientists that these three species are closely related; *E. occidentalis* may even have had stripes! However, plant matter preserved in the teeth indicates that this extinct horse consumed a higher percentage of browse than its living counterparts.

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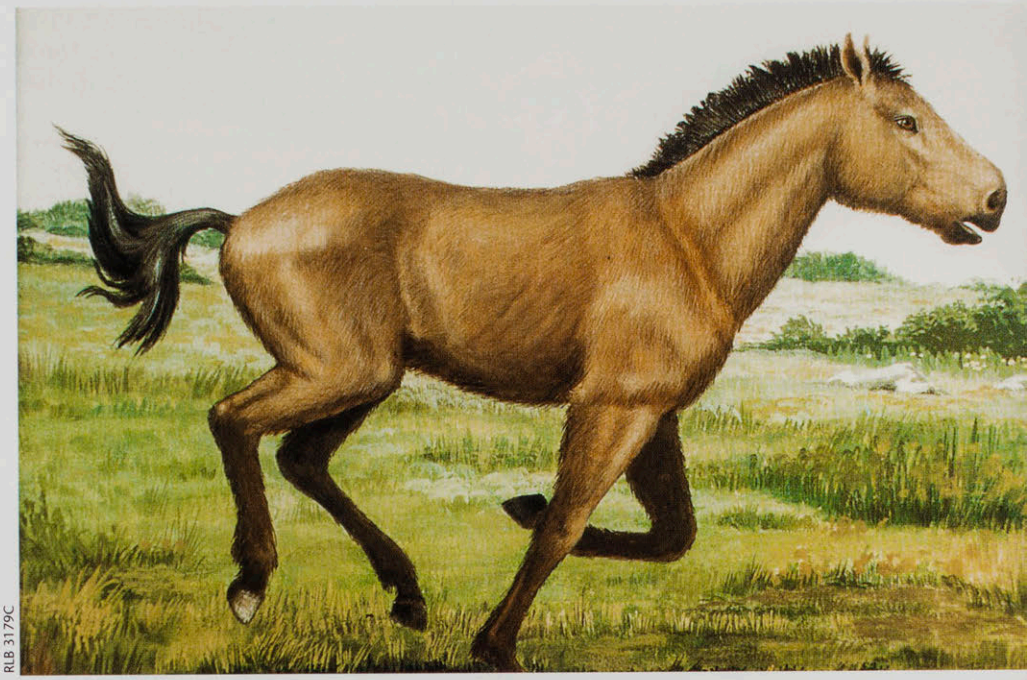
Juveniles between one month and one year in age predominate in the sample of *Equus occidentalis* from Rancho La Brea, but adult males outnumber adult females by nearly 2 to 1. Analyses of limb elements indicate that *E. occidentalis* underwent a small but significant reduction in body size towards the end of the Pleistocene, around 15,000 years ago. This reduction in body size may have been a response to changing environmental conditions as the Ice Age drew to a close. *E. occidentalis* is common in late Pleistocene fossil assemblages throughout southern California and has also been reported from numerous localities of latest Pleistocene age in Arizona, Nevada and New Mexico.

Equus conversidens, one of the smallest horse species from the North America Pleistocene, was similar in size to the modern burro, *E. asinus*. It is relatively rare in fossil assemblages from the coast and inland valleys of southern California but was more common in the high desert regions. This horse probably preferred lush, open country, although its range did extend into more arid regions.

Eric Scott is Curator of Paleontology at the San Bernardino County Museum of Natural History and a research associate of the Rancho La Brea Department.

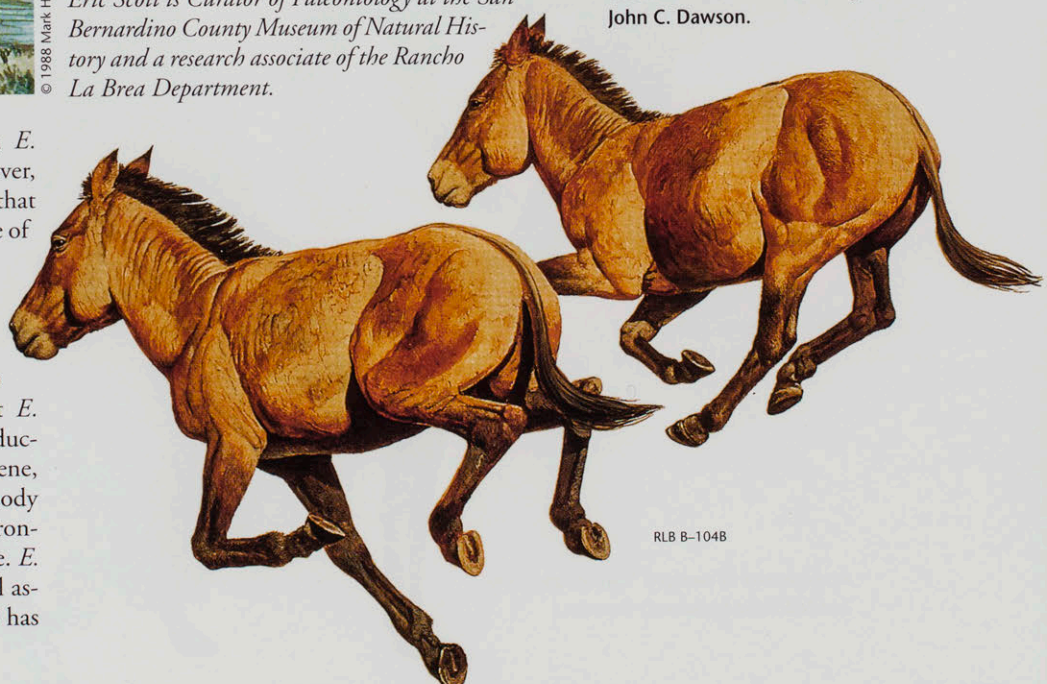


RLB 3179C

ABOVE
Western horse restoration by Mary Butler.

LEFT
Western horse restoration by Mark Hallett.

Western horse restoration by John C. Dawson.



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Rancho La Brea Camels

by Christopher A. Shaw

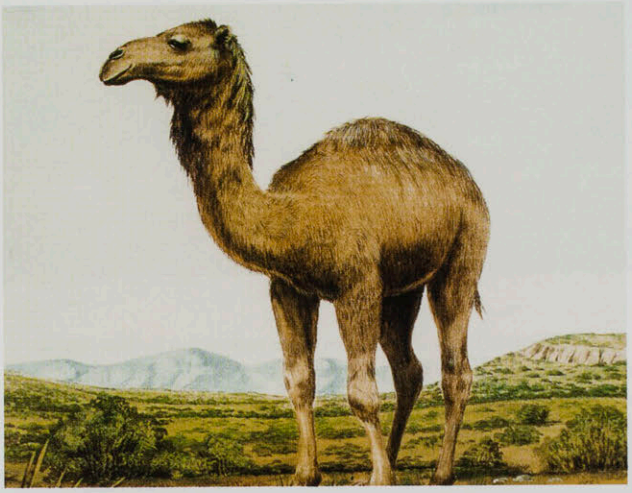
Most of the evolution of the camel family (Camelidae) took place in North America. Of the six species that survived into the late Pleistocene, two have been recovered from Rancho La Brea. However, camels are relatively rare at this site.

Camelops hesternus ("yesterday's 'camel'") was the larger and more commonly preserved camelid species at Rancho La Brea. A sample of over 2,700 bones represents at least 36 individuals. Elsewhere, this species is the best-known late Pleistocene camel and occurred throughout western North America.

Camelops hesternus had a slender skull with a long muzzle. It may have possessed a deeply split, well-muscled, pendulous but mobile, upper lip for grasping food. Its long neck and legs were about 20 percent longer than those of the living dromedary. "Yesterday's 'camel'" stood seven feet tall (2.1 m) at the shoulder region and had steeply sloping hindquarters and a relatively short tail. The structure of its footbones allies *Camelops* with llamas; whether or not *Camelops* had a hump as in living camels is still disputed.

The large-headed llama *(Hemiauchenia macrocephala)* is a very rare component of the Rancho La Brea fauna. Only a dozen bones have been identified from Rancho La Brea, and these represent not more than seven individuals. Though rare at Rancho La Brea, *Hemiauchenia* is a common component of Pleistocene assemblages from the southern San Joaquin Valley, Mojave Desert, and in the Great Plains.

The skull and skeleton of *Hemiauchenia macrocephala* is similar to but larger than those of modern llamas and it had proportionately longer limbs and a longer neck. *Hemiauchenia* had a long stride that may have been adapted for running in open plains. However, the limb proportions appear to parallel those found in the African gerenuk *(Litocranius walleri)* and some paleontologists speculate that *Hemiauchenia* (like gerenuks) could stand upright on its hind legs to browse from the highest and most succulent leaves. The tall teeth of both *Camelops* and *Hemiauchenia* were formerly interpreted as an adaptation for grazing but microwear and isotopic analyses suggest that most camels were browsers. In fact, grasses were evidently rare in the vicinity of Rancho La Brea. Plant fragments extracted from the teeth of *Camelops* from this site comprised less than 11 percent grass tissue, suggesting that this extinct species was an opportunistic herbivore like the living dromedary.



RLB 3190 c

Restoration of western "camel" by Mary Butler.

Restorations of western "camel" and long-headed llama by John C. Dawson.

Rancho La Brea Bison

by George T. Jefferson

RLB 2289C

Two month-old ancient bison jaw with deciduous premolars and erupting first molar. The state of wear of the bison teeth from Rancho La Brea suggests that bison were only present in the area for about two months each year.

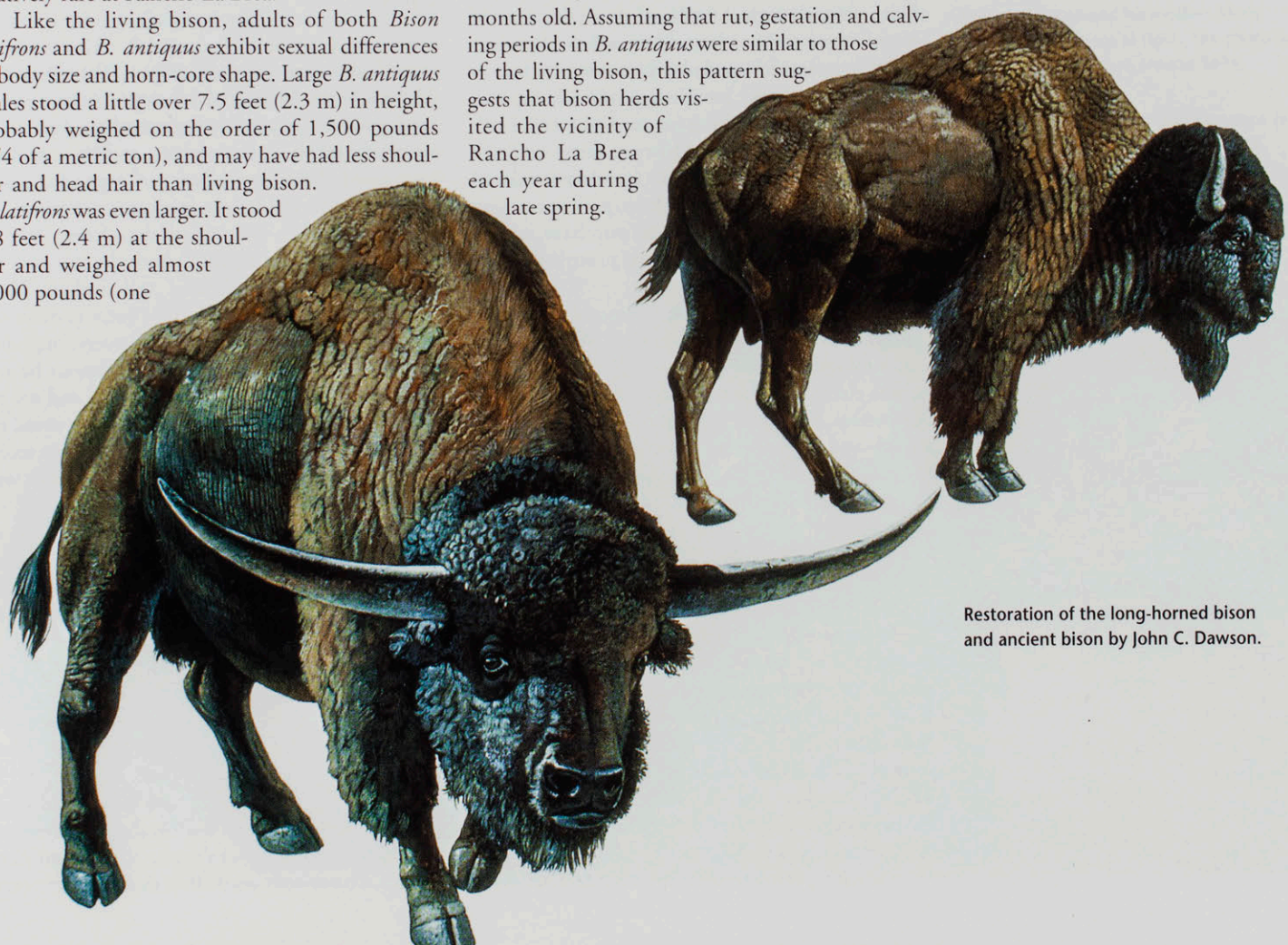
BISON BELONG TO THE CATTLE FAMILY (BOVIDAE), and are first recognized in the fossil record of Eurasia nearly two million years ago. The first appearance of bison south of the North American continental Pleistocene ice sheet is generally accepted as the time marker for the beginning of the Rancholabrean Land Mammal Age, about 250,000 years ago. Different bison species are usually distinguished by the size and shape of their horn cores, which in living animals are covered by a thin, horny sheath.

Two species of bison are known from Rancho La Brea—*Bison latifrons*, the long-horned bison, and *B. antiquus*, the ancient bison. The former was the largest bison from North America, and its long horn cores measure more than 7.2 feet (2.2 m) from tip to tip. Although smaller than *B. latifrons*, and with much shorter horn-cores (39.37 inches or 1 meter) spread, *B. antiquus* was still larger than its direct descendant, the living *B. bison*. *B. antiquus* is the most common large mammalian herbivore in the Rancho La Brea assemblage. It is represented by more than 300 individuals, exceeding the combined numbers of horses and camels. In contrast, *B. latifrons* is relatively rare at Rancho La Brea.

Like the living bison, adults of both *Bison latifrons* and *B. antiquus* exhibit sexual differences in body size and horn-core shape. Large *B. antiquus* males stood a little over 7.5 feet (2.3 m) in height, probably weighed on the order of 1,500 pounds (3/4 of a metric ton), and may have had less shoulder and head hair than living bison. *B. latifrons* was even larger. It stood 7.8 feet (2.4 m) at the shoulder and weighed almost 2,000 pounds (one metric ton). However, it may have lacked the thick shoulder and head hair seen in many reconstructions.

The long-horned bison was apparently adapted to wooded or forested habitats. It ranged throughout the mid-continental United States but is not well represented at fossil localities in southern California. The ancient bison ranged across the southwestern United States and northern Mexico and was a mixed feeder adapted to wooded or savanna steppe environments. Evidence from Rancho La Brea, which supported a predominantly coastal sage scrub floral community, suggests that here *B. antiquus* may have fed mainly by browsing.

An annual migration of *Bison antiquus* is suggested by clusters of young animals two to four months old, 14 to 16 months old and 26 to 28 months old. Assuming that rut, gestation and calving periods in *B. antiquus* were similar to those of the living bison, this pattern suggests that bison herds visited the vicinity of Rancho La Brea each year during late spring.



Restoration of the long-horned bison and ancient bison by John C. Dawson.

Chester Stock: A Memorable Fossil Hunter 1892-1950

by Cathy McNassor

IF YOU HAVE A MENTAL PICTURE OF A FOSSIL hunter from the early part of this century as being dashing and glamorous, like someone from an adventure movie, you probably would have been disappointed by Chester Stock. Not unduly handsome, short in stature, and with dark red hair and glasses, Stock was no "Indiana Jones." He was a friendly, straightforward man, a bit deaf in later life, with a dry sense of humor and a fondness for silly puns. He had a single-minded devotion to the study of bones of long extinct animals that bordered on an obsession, for above all else, he was a paleontologist.

Chester Stock was one of the most important paleontologists to have been associated with the Los Angeles County Museum of History, Science and Art (later to become the Natural History Museum of Los Angeles County). Today he is best remembered for his classic study of the fossil mammals from Rancho La Brea and, even fifty years after his death, his publications on this topic continue to be primary sources of information for paleontologists who are currently investigating this extraordinary site. His research interests were, however, much wider-reaching, and for decades he directed and controlled much of the paleontological exploration of the western United States and northern Mexico. Stock's impact on the museum still persists. The vast numbers of fossils amassed under Stock's direction and supervision when he was working for the California Institute of Technology (Caltech) now form a significant portion of the museum's vertebrate paleontology collections. Some of the superb specimens that he acquired through trade, purchase, or collecting expeditions still feature prominently in the museum's exhibits.

In his lifetime Stock was something of a national celebrity, and his name is still well known in paleontological circles. Three weeks before his death, he was elected president of the Geological Society of America. Stock was, however, a very private individual, and even the scientists now working with his collections and publications know very little about the personal history of the man. He has long been a legend at the Natural History Museum of Los Angeles County because of the number and scope of his publications and the extent of the collections built up under his supervision. Indeed, Stock's "presence" is so pervasive at the museum that for years it has been rumored that he haunts the vertebrate paleontology collections on the fourth floor. Staff and researchers working late at night have been repeatedly startled by footsteps, whistling, and sounds of fossil cabinets being opened and closed. These mysterious phenomena have yet to be satisfactorily explained other than by attributing them to "Chester's ghost" still tending his fossils.

Stock's personal correspondence files were recently transferred to the George C. Page Museum's Chester Stock Memorial Library, where they are catalogued and accessible to researchers. He was an extremely active correspondent, and he appears to have saved almost every piece of paper that came into his hands. His letters, postcards, telegrams, receipts, and other documents date from 1913 to 1950, and reveal much about both the man and the fossil specimens he collected and studied. These papers are particularly important because other significant records pertaining to his career, including most of the field notes for the specimens he collected, disappeared after Stock's death and are rumored to have been destroyed. In many cases, the remaining correspondence is the only existing record of when and from where important specimens were collected.

Chester Stock Memorial Library

Chester Stock examining dire wolf skulls and teeth in 1939.

Chester Stock was born in San Francisco on January 28, 1892, to German immigrant parents, and spent his early years in the poorer section of the city. He showed an early interest in science and was fascinated by the mining displays at the annual Mechanics Fair and by the reconstructions of prehistoric animals at the California Academy of Sciences. Education was emphasized in the Stock family, and, in addition to his regular schooling, Chester was tutored in German, took tuba lessons, and attended the Lutheran church and Sunday school.

In 1906, when Stock was 14, the great San Francisco earthquake and fire devastated the family's resources. Thirty-four years later, this traumatic event

was recalled in a letter to Chester from his brother Alfonso as "that awful shaking, crunching of timbers . . . and hectic happenings . . . In that time we forgot that you were out on Bryant Street trying to get back into the house, you having banged out the big front window and jumped out in your PJ's." To help redress the family's dire financial situation, Chester dropped out of high school to work at Old Union Iron Works, but became ill because of the hard labor and a bout of malaria. After his recovery, his mother and brother decided that Chester should return to high school. He graduated with honors and entered the University of California at Berkeley in 1910. Stock had intended to study medicine, but, early in his college career, he met paleontologist John C. Merriam, who kindled Stock's lifelong fascination with extinct animals.

Under Merriam's tutelage, Stock earned B.S., M.S., and Ph.D. degrees at Berkeley within seven years and published his first scholarly paper at age 21 in 1913. Stock also helped excavate many paleontological sites for the university and participated as an undergraduate in the Berkeley dig at Rancho La Brea. Merriam took a personal interest in Stock, guiding his research towards significant projects and launching his prodigious writing career. For his Master's project, Stock was assigned the ground sloths of Rancho La Brea. His fascination with sloths continued after the degree was completed, eventually leading to the publication in 1925 of *Cenozoic Gravigrade Edentates of Western North America*, which is still considered the major work on the subject.

Some of the superb specimens that he acquired through trade, purchase, or collecting expeditions still feature prominently in the museum's exhibits.

In 1908, fossils of both early man and other animals had been discovered at Hawver Cave, near Auburn, California. Archaeologists of that time presumed that the Pleistocene faunas found in caves had coexisted with early man in the New World. Merriam had studied the human remains from Hawver cave but believed they were younger than the associated fossil animal bones. He assigned Stock the task of proving or disproving this association for his doctoral research. Stock's interest in early human remains and their possible association with Pleistocene animals continued throughout his career, as did his fascination with the fauna of the Rancho La Brea "tar pits."

Merriam left Berkeley in 1921 to become president of the Carnegie Institute of Washington, a major granting institution, but the close association between the two men continued until Merriam's death in 1945. Even though Stock achieved his own professional reputation, their relationship often resembled that of teacher and student. R. W. Wilson, one of Stock's students in the 1930s and later an eminent authority on fossil rodents, remembers being disturbed by Merriam's ordering Stock around as if he were still

LEFT
Stock, about two years old, perches on the knee of his father, John Englebert Stock. His brother Alfonso and his mother, Maria Henriette Stock, are at right. The photo was taken in San Francisco around 1894.

RIGHT
Stock, about 23, poses in San Francisco in 1915 with three friends identified as A. Stolz, S. Gray, and L. Kreamer.

Courtesy John C. Stock

Courtesy John C. Stock

Courtesy John C. Stock

VP 509

ABOVE
Chester Stock and his family at their home in Pasadena in 1928.

BELOW
Chester Stock (center) with Caltech colleagues John Maxon and Eustace Furlong on a collecting expedition to the John Day fossil beds of Oregon in 1927. Oligocene and early Miocene fossils were recovered from the beds.

an underling. Nevertheless, Merriam must have had a great deal of respect for Stock's abilities, as he often solicited his opinion about which paleontological research projects deserved financial support from the Carnegie Institute. Merriam also ensured that the Carnegie Institute funded Stock's projects and published many of his major papers. In 1932, the two men coauthored the paleontological masterpiece on fossil cats, *The Felidae of Rancho La Brea.*

After the completion of his doctorate in 1917, Stock became a teaching assistant at Berkeley and in 1919 he was promoted to instructor. In the early 1920s, Stock drove back and forth between Berkeley and Los Angeles countless times so that he could study the Rancho La Brea fossils collected by the Los Angeles County Museum. He logged "over one million miles" during this period, according to Henry Wylde, who later worked under Stock as assistant paleontologist at the museum. In addition to his teaching and his research on Rancho La Brea, Stock participated in Berkeley's field expeditions to the Miocene fossil beds of Oregon's John Day region, the McKittrick tar seep deposits near Bakersfield, and other western fossil sites. Despite his busy professional activities, Stock found the time to court Clara Margaret Dowd of San Francisco. They were married on June 2, 1921, and shared a very close and happy relationship. Clara Margaret gave birth in 1923 to the couple's first child, Jane Henriette. In November of that year, Stock wrote to Princeton paleontologist William J. Sinclair that because of Jane he was "happily disillusioned as so far as babies go" and that the baby ". . . never has the colic . . . she passes the day laughing and cooing and has just discovered her toes, thinks her father is a great joke, and sleeps like a cherub at night." A few years later, their second child, John Chester Stock, was born.

In 1925, R. A. Millikan, Nobel prize-winning physicist and president of Caltech in Pasadena, was searching for faculty to create a strong new Division of Geological Sciences. Upon Merriam's recommendation, Millikan offered the position of department chairman to J. P. Buwalda, one of Stock's Berkeley colleagues, but he was also very impressed with Stock and offered him a professorship in the new department. Though the decision to leave Berkeley was not easy for Stock, Millikan's proposal was especially generous and very tempting. With the goal of building "under Stock's leadership an altogether outstanding center of paleontological research" at Caltech, it was agreed that Stock would be appointed full professor, have a yearly salary of $6,000, an endowment of $200,000 ($10,000 annually) for research, and "large freedom from instructional duties." Another decisive factor was Caltech's geographical proximity to the Los Angeles County Museum, with its collection of Rancho La Brea fossils. J. P. Buwalda and Stock accepted their positions at Caltech in 1926, and together they created a vertebrate paleontology department that dominated the field on the west coast in the ensuing decades.

Although a popular professor, Stock was a notoriously disorganized lecturer in his undergraduate classes, according to R.W. Wilson, often losing his place and wandering off the subject. As a graduate professor, however, Stock excelled and inspired many students with his love for paleontology. Stock built up the fossil collections at Caltech for teaching, display, and research purposes, and many student expeditions to the field were organized. In special cases, Stock hired additional "field men" to prospect for sites and excavate them. Wesley Bliss, hired in this capacity on many occasions, recalls that Stock was a good employer because he respected the abili-

ties and opinions of his men and let them do their jobs. Stock's practice of sending a cook along on expeditions freed the excavators to spend all their field time in the pursuit of fossils.

Once in Los Angeles, Stock became further involved with the Los Angeles County Museum. He played an important role in the museum's vertebrate paleontology programs, directing research and fossil collecting activities. Though he had been affiliated with the museum since his undergraduate days, and spent much of his time with "museum work," Stock was not actually a museum employee until 1931, when he was officially hired part-time as a curatorial consultant.

Tragedy came into Stock's busy and happy life in 1934. Clara Margaret was taken ill in November of 1933 while Stock was on the east coast visiting with professional colleagues. He rushed home, and she was operated on in December for what appeared to be gallstones. The surgery disclosed that her malady was actually cancer of the pancreas, but, as was common at that time, cancer was never mentioned, and Clara Margaret was not told that she was going to die soon. A young niece was sent from the east to take care of the children and the housework and to nurse Clara Margaret. The emotional strain is obvious in Stock's correspondence and many letters went unanswered for months. After Mrs. Stock succumbed in early April of 1934, Stock apparently diffused his grief through research and writing, penning numerous letters and publishing several articles in the year following her death.

J. P. Buwalda and Stock accepted positions at Caltech in 1926, and together they created a vertebrate paleontology department that dominated the field on the west coast.

A little over a year later, Stock married a Caltech employee somewhat younger than himself, Margaret Gardner Wood. According to Wilson, she was not as outgoing as Clara Margaret, but she was proud of her husband's accomplishments and they had a very active social life.

Stock stopped actively participating in field work in 1930, after he had suffered a serious bout of kidney stones while in a remote area. However, he continued to send his students and field men out to collect fossils. Stock was thus involved with most of the major paleontological and archaeological excavations undertaken in the western United States during the 1930s. He worked closely with M. R. Harrington of the Southwest Museum identifying the remains of extinct animals found in association with early man at many sites, the most famous being Gypsum Cave in Nevada. Stock's expertise was considered essential, and great efforts were made to get him to visit significant sites to offer his opinion.

Aware of the exciting potential of fossil sites in northern Mexico, in 1931 Stock sent Wesley Bliss, one of his best field excavators, on an extended exploratory journey of this dangerous, wild territory. Not only were the roads almost impassable, the country was politically unstable, and northern Mexico in particular was the hideout of bandits and revolutionaries. Bliss's fluent Spanish proved essential for navigating the area and locating fossil deposits. In the small town of Arremberri, Nuevo Leon, he encountered a Mexican lad who knew of a place where there were many bones. After an all-day journey up the side of a mountain, they arrived at San Josecito cave. According to Bliss, every cave in Mexico was reputed to be hiding treasure, either left behind by the Spaniards or by revolutionaries. Here, in the debris left by treasure hunters, Bliss found that "there was as much bone as matrix." San Josecito Cave turned out to be a very important Pleistocene site.

Impressed by the fossils Bliss had sent him from the cave, Stock organized another expedition to San Josecito in 1935. Though the site was obviously very rich, the hazard and expense of excavating needed be seriously weighed. Stock made his decision, and with a $10,000 grant from the Carnegie Institute of Washington, serious digging began in 1936. Over the next several years, the San Josecito Cave yielded thousands of exquisite bones of extinct animals. Six skeletons from this site are still on display today at the Natural History Museum.

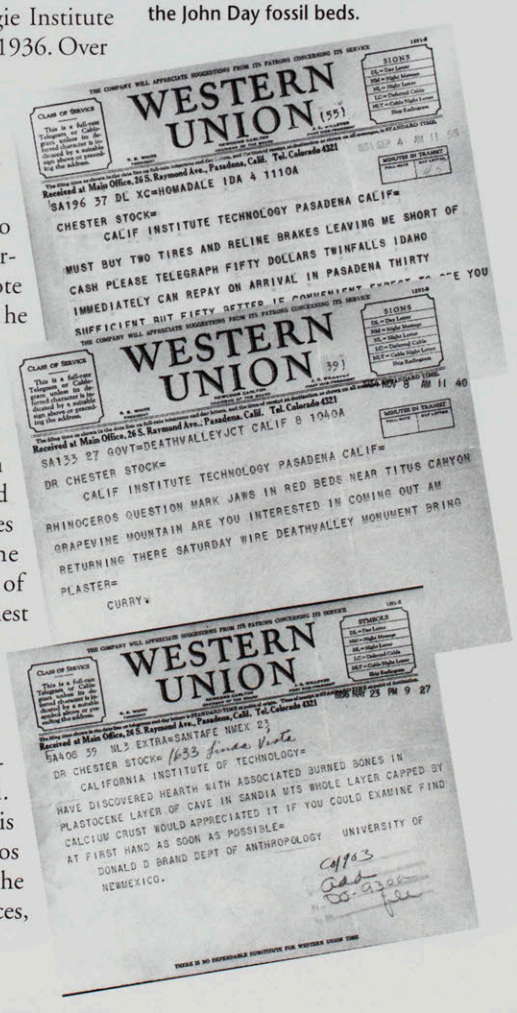
In the mid-1930s, Stock began to publish popular as well as scientific articles. Between 1935 and 1941, he wrote 16 articles for *Westways* magazine, and he managed to get his fossils into the newspapers on a regular basis. He was a popular lecturer, willing to travel anywhere to talk about Rancho La Brea and show his impressive collection of lantern slides. In the 1940s, he also organized popular exhibitions for the Los Angeles County Museum. His exhibit on the evolution of the horse, "The Ascent of *Equus*," had some of Hollywood's richest and most influential people for patrons.

The onset of World War II reduced financial support for collecting expeditions, and with many of Stock's colleagues and students in military service, paleontological studies slowed. During the war years, in addition to his regular work at Caltech, and at the Los Angeles County Museum where now he served as Senior Curator of Earth Sciences,

(Continued on page 40)

Courtesy John C. Stock

Chester Stock in Oregon in 1942 to examine fossils that his collectors had retrieved from the John Day fossil beds.



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DONALD D BRAND DEPT OF ANTHROPOLOGY UNIVERSITY OF NEWMEXICO.

Chester's Ground Sloths

by H. Gregory McDonald

During his career, Chester Stock undertook research on many different kinds of vertebrate fossils from the western United States and northern Mexico. Guided by his mentor, the eminent paleontologist John C. Merriam, Stock focused on the ground sloths of Rancho La Brea for his Master's thesis at the University of California, Berkeley. His interest in these animals continued for many years afterward and his 1925 publication Cenozoic Gravigrade Edentates of Western North America *is still considered the definitive work on the subject*

OF THE ANIMALS RECOVERED from the asphalt deposits at Rancho La Brea, perhaps none catches the visitor's attention more quickly than the giant ground sloths. Two skeletons of these ancient relatives of today's two- and three-toed tree sloths, anteaters and armadillos are reconstructed at the Page Museum, and their strange anatomy truly satisfies our expectations of what "prehistoric beasts" should look like. Even to paleontologists the remains of ground sloths appear to be incongruous with those of other "normal" mammals.

These large herbivores exhibit many anatomical peculiarities. Their teeth were composed only of dentine with no enamel, and were evergrowing. In fact, sloths never developed a separate set of deciduous (baby) teeth like other mammals, keeping only the set with which they were born. Sloth skulls had a distinctive expansion of the cheekbone that provided a large area for attachment of massive cheek muscles, which increased chewing efficiency. Their front feet were equipped with large claws that could have been used in gathering plants as well as for self-defense. While most mammals have just one set of ribs (costal ribs), ground sloths possessed an additional set (sternal ribs) that connected the costal ribs to the sternum (the original double-breasted suit). Fusion between the ischium (a pelvic bone) and some caudal (tail) vertebrae formed a solid structure called a synsacrum, and created the animal's massive pelvis. Overlapping processes on the lumbar (lower back) vertebrae provided additional support when the sloth was sitting upright.

Finally, the structure of the hind foot was strange, one of the most interesting departures from the normal mammalian condition: in some species the hind foot was rotated so that the sole faced inward. The result of this arrangement would have been that, as the animal began to raise its foot, the foot would rotate inward, pushing the hip to the side. These combined movements probably produced a waddling gait, with the hips shifting back and forth at each step.

Ground sloths originated and evolved on the island-continent of South America before the Panamanian Land Bridge connected the two American continents about three million years ago. By the Late Pleistocene, four species were present in North America. All were herbivores but each had its particular ecological requirements. The largest species, truly a giant, was *Eremotherium miralne*, an animal equal in size and bulk to an elephant. Smaller, but still of impressive size, was Harlan's ground sloth (*Paramylodon harlani*) followed by Jefferson's ground sloth *(Megalonyx jeffersoni)*; the smallest (relatively speaking) was the Shasta ground sloth (*Nothrotheriops shastensis*). Rancho La Brea is the only North American site where three of the four (*Megalonyx*, *Nothrotheriops*, *Paramylodon*) have been found together. In fact, bones of all three species have been found in two localities—Pits 3 and 67.

Megalonyx jeffersoni is the rarest ground sloth recovered from Rancho La Brea. *Megalonyx* (meaning "great claw" and referring to the large claws of the forelimb) was the named coined by President Thomas Jefferson. On March 10, 1791, Jefferson read before the American Philosophical Society of Philadelphia a paper entitled "A Memoir on the Discovery of certain Bones of a Quadruped of the Clawed Kind from the Western Parts of Virginia," in which he suggested—correctly—that the forearm and hand bones recovered from a cave in Greenbriar County, Virginia, during a saltpeter mining operation belonged to an animal that was distantly related to the South American sloth *Megatherium*. In 1820, work by the French scientist Desmarest confirmed Jefferson's suggestion, and the species *Megalonyx jeffersoni* was named to recognize our third president's contribution to the fledgling science of paleontology. *Megalonyx* has the distinction of being the first ground sloth found in North

Restoration of the Shasta ground sloth, *Nothrotheriops shastensis*, by Charles R. Knight for Stock's 1925 monograph on ground sloths from Rancho La Brea.

RLB 963

America and the second type ever scientifically described. Its remains have been found from Alaska to Mexico and from coast to coast, making it the most widely distributed of the group. It was different from the other sloths in that it had enlarged tusk-like front teeth and long forelimbs adapted for reaching. Its wide pelvis and massive synsacrum suggest that it could sit upright.

The largest and most commonly preserved ground sloth from Rancho La Brea is *Paramylodon harlani*; in fact, Rancho La Brea has the largest sample of this species from any single fossil site. Charles Darwin discovered and first collected remains of this sloth in South America. Sir Richard Owen described the species for which he coined the name *Glossotherium* ("tongue beast"); he suggested the animal had a large prehensile tongue that was used in feeding, much like a giraffe's. However, the species is better referred to the older genus name *Paramylodon* (*para* = near, *mylo* = molar, *odon* = tooth); as this North American animal is very similar to the South American sloth *Mylodon*. The specific name honors Richard Harlan, who first described a jaw of this animal from Big Bone Lick, Kentucky.

Unlike those of *Megalonyx* or *Nothrotheriops*, *Paramylodon*'s skeleton was stout, and it had shorter, more powerful limbs. This animal was built closer to the ground and probably grazed rather than browsed on vegetation. Fossil trackways found in Nevada provide some insight into the gait and stride of these animals. Because it walked on the outer side of its hind feet, one might assume that *Paramylodon* was slow and clumsy, easy prey for large carnivores. However, it had one trick up its sleeve as well as on most of its back: the most common fossil bones of this animal at Rancho La Brea are dermal ossicles—small, pebble-like nodules that were embedded in its skin. These functioned as armor. Mummified hide from a cave in South America reveals that the ossicles formed a solid pavement in the skin.

The smallest of the Rancho La Brea ground sloths, *Nothrotheriops shastensis*, was first recognized from Potter Creek Cave in Shasta County, California. *Nothrotheriops* means "sluggish or slothful beast."

Like *Megalonyx*, *Nothrotheriops* had relatively long limbs and front feet with large claws to hook the bushes and shrubs upon which it fed. However, its skull was long and narrow and lacked the tusks of *Megalonyx*. Like *Paramylodon*, it probably used its tongue for gathering food, but it was more selective about which plant parts it consumed.

RLB 962

Dry caves in the arid southwest commonly preserve the skin, hair, claw sheaths, and dung as well as the bones of *Nothrotheriops*. Species of 72 plants have been identified in the dung, which allows a detailed reconstruction of the animal's diet; many of these plants are also known from Rancho La Brea.

The diversity of ground sloths and other herbivores at Rancho La Brea is impressive and is indicative of the diversity of vegetation and habitats in the region during the late Pleistocene. Although ground sloths, mammoths, mastodons, camels, horses, bison, and antelopes co-existed at Rancho La Brea, each utilized a particular aspect of the environment. Four plant groups (coastal sage scrub, chaparral, deep canyon, and riparian) were present in the area. *Nothrotheriops* probably foraged in the coastal sage scrub; food preferences of *Megalonyx* and *Glossotherium* are still open to speculation. As more ground sloth fossils are recovered, their ecology and evolution will be clarified. For now, one of the keys to understanding these animals is Rancho La Brea.

H. Gregory McDonald is Paleontology Program Manager of the National Park Service's Geologic Resource Division and a research associate of the Rancho La Brea Department.

Fossil skulls of the large Harlan's ground sloth, *Paramylodon harlani* (below), and smaller Shasta ground sloth *Nothrotheriops shastensis* (above).

Courtesy Jane Stock Sullivan

Chester Stock measuring a fossil while a graduate student at the University of California, Berkeley. Note the mounted tree sloth skeleton, and the ground sloth skull on the right side of the desk. The photograph appears to have been taken in Bacon Hall, Berkeley's geology building, about 1915.

Stock was a part-time geologist for the U. S. Geological Survey. His home life was marked by the birth of his third child, James Ellery, in 1942.

After the war ended, Stock once again turned his attention to Rancho La Brea. He again revised his popular book, *Rancho La Brea, a Record of Pleistocene Life in California*, and new editions were published by the museum in 1946 and 1949. Stock originally published this book in 1930, with the second edition appearing in 1942. In the mid-1940s, major improvements were needed at Hancock Park, for it was overgrown and had become a woeful eyesore. Stock, a driving force behind the new plans for the park, felt that an on-site museum was crucial so that visitors "will have the opportunity to fully appreciate the actual remains of these ancient animals and plants, how they are prepared and studied by the scientists, as well as the all important facts of their occurrence."

In 1948, Stock became Chief Curator of Science at the Los Angeles County Museum. In the same year, a master plan for the redevelopment of Hancock Park as a scientific landmark was approved by the Museum Board of Governors and the County Board of Supervisors. The project was expected to take seven to ten years to complete and would totally change the park's appearance. It specified relandscaping with the original components of Pleistocene vegetation, replacing walls, fences, walkways, building an observation pit over an existing fossil deposit, and the construction of a paleontology museum to house and exhibit the Rancho La Brea fossils. Stock explained his own concept in a speech delivered to the Board of Supervisors in 1949:

> It is safe to say that another park of this type exists nowhere in the world. The site, the remarkable material which has come from it, the opportunity which this material affords in presenting interesting facts, the location of the site, and the excellent climatic conditions make it ideal for an outdoor museum, and that is in essence what it is intended to be.... It should remain a pleasant place in the great metropolitan community where one, if so minded, can commune with nature, contemplate the meaning of earth change and the change of living things upon the earth, and once again give thought to the true meaning of time and the extraordinary story revealed by these dark mirrors of the past.

In 1957, the marvelous collection of vertebrate fossils amassed by Stock for Caltech was purchased by the Los Angeles County Museum for the then vast sum of $100,000.

Stock did not live to realize his dream of a museum at Rancho La Brea. In the early morning hours of December 7, 1950, he suffered a brain hemorrhage and died at his home in Pasadena.

Stock's untimely death significantly undermined the efforts to redesign Hancock Park. The re-landscaping was completed, as was the Observation Pit, which was dedicated to Chester Stock on December 8,1954. However, Stock's vision for a La Brea museum at Hancock Park died with him, a casualty of inadequate funding and the loss of the driving energy and enthusiasm that Stock brought to the project. If it had not been for the enterprise of George Page some two decades later, Stock's dream may have been lost forever.

A year after Stock's death, the California Institute of Technology deleted vertebrate paleontology from its curriculum. In 1957, the marvelous collection of vertebrate fossils amassed by Stock was purchased by the Los Angeles County Museum for the then vast sum of $100,000. Now known as the C.I.T. collection, it provides the core of the museum's vertebrate paleontology collections and exhibits.

Chester Stock's pioneering research in the field of vertebrate paleontology, and his tireless enthusiasm for sharing his knowledge with the public, has left us all with a rich legacy. His popularization of the "tar pits" has shaped the perceptions that most people have of this site, and most of Stock's insights on Rancho La Brea are still applicable today. The fossils he so carefully collected still bring awe and pleasure to the visitors of the Natural History Museum. And one can only wonder what he would think if he could see the George C. Page Museum of La Brea Discoveries, which fulfilled his lifelong wish for a museum built in Hancock Park to house the precious fossils from Rancho La Brea. Most likely he'd be pleased.

Cathy McNassor is the museum archivist and archivist for the Rancho La Brea Department at the Page Museum. *Special thanks for assistance with this article go to: the late Wesley Bliss, Joan Hoch, the late Hildegarde Howard, Gretchen Sibley, Alden Stock, John C. Stock, Jane Stock Sullivan, John Sullivan, and Robert W. Wilson.*

George Allan Hancock 1875-1965

by Cathy McNassor

THE PRESERVATION OF THE EXTRAORDINARY fossil beds at Rancho La Brea can be credited solely to the foresight and generosity of Captain G. Allan Hancock. His recognition of the monumental scientific value of the site, and a desire to preserve it for future generations, led to the donation of the 23 acres now known as Hancock Park to the County of Los Angeles. In 1913, he gave the exclusive right to excavate to the new Los Angeles County Museum of History, Science and Art.

Hancock, an entrepreneur whose fortune came from oil, real estate, and banking, had diverse personal interests that included automobiles, aviation, higher education, and marine science. He had a longtime interest in the fossils of Rancho La Brea and, though he received many offers to purchase the "tar pits" land, he felt it should be retained by and for the people of Los Angeles County as a park. In keeping with his deep respect for knowledge and scholarship, he stipulated in his gift that the scientific features of the site be preserved.

Courtesy Dr. John Garth, Allan Hancock Foundation

Hancock capturing a spotted chuckwalla, *Sauromalus varius*, during a *Velero III* expedition in 1936. This animal is found only on San Esteben Island in the Gulf of California.

Courtesy Dr. John Garth, Allan Hancock Foundation

Hancock's interest in the fossils of Rancho La Brea paralleled a longtime fascination with marine science, and he led and funded research expeditions aboard his *Velero* vessels for more than 20 years. Eventually, in 1939, he established the Allan Hancock Foundation for Scientific Research at the University of Southern California.

Seaver Center general file photo 8702A

G. Allan Hancock, whose father died when Allan was eight, spent his childhood helping his widowed mother fight squatters' claims and other legal battles to keep from losing Rancho La Brea. When Allan was 10, the first successful oil wells were drilled on the Hancock property. This picture was taken about the time he started his own oil company with a seed loan of $10,000 from his mother. Within a short time, the income from his first well paid off both the loan and the mortgage on Rancho La Brea. By 1912 he had drilled 28 wells, and the Hancocks became one of the wealthiest and most socially prominent families in Los Angeles.

James Zacchaeus Gilbert 1866-1945

by Cathy McNassor

J.Z. Gilbert Collection 4601

Gilbert with newly excavated mastodon skull.

James Z. Gilbert, a biology teacher at Los Angeles High School, excavated at Rancho La Brea between 1907 and 1910. He brought the site to the attention of the Southern California Academy of Sciences and, with funds provided by the city and county, supervised his students in the excavation of one fossil deposit for the academy. The Museum of History, Science and Art, founded in 1910, was created in part to house the Southern California Academy's collection. Rancho La Brea specimens collected by Gilbert and his students were among the first exhibits at the new museum. The Southern California Academy's collection was donated to the county in 1913. In addition, Gilbert amassed a large collection of Rancho La Brea fossils for teaching paleontology at Los Angeles High School.

Gilbert was born and educated in Indiana, receiving degrees from McPherson College in 1894 and 1919. He studied paleontology under S. W. Williston at University of Kansas, and obtained an A. M. degree in 1895. He came to California in 1904 to teach at Los Angeles High School, a position that he held until his retirement in 1938. He was very active in the Southern California Academy of Sciences, publishing his first report on Rancho La Brea in their 1910 bulletin.

J.Z. Gilbert Collection 4603

Gilbert with bison skull at the academy excavation.

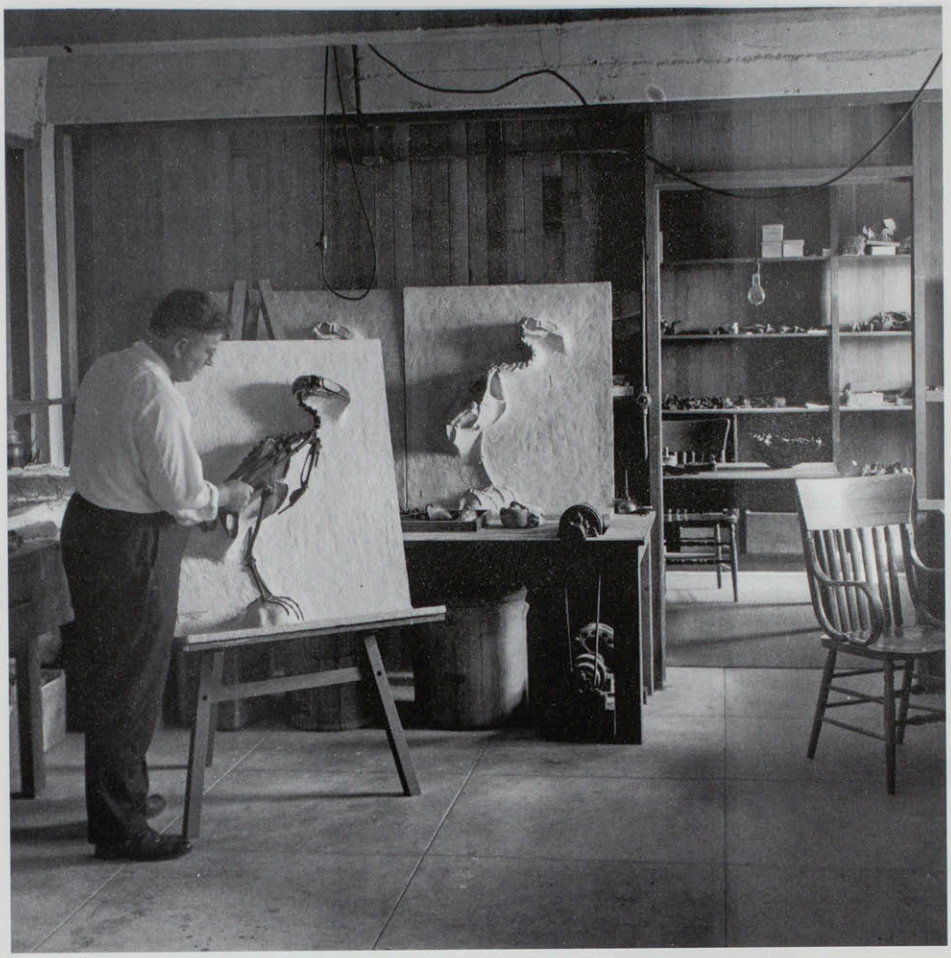
James W. Lytle 1886-1931

by Cathy McNassor

James W. Lytle, a talented and creative influence on the early research at Rancho La Brea, came to paleontological work from a diverse and unlikely background. After completing the eighth grade, Lytle worked as a brick layer, and later a railroad man, before moving to California from his native Illinois in 1912. On September 13, 1913, Lytle was hired by the Los Angeles County Museum of History, Science and Art as a "washer of bones," during the early excavations at Rancho La Brea. He soon had invented a new method of cleaning asphaltum off excavated specimens using boiling kerosene. He also developed new methods of excavating the fossils, which entailed digging from the sides of the deposits rather than the top, greatly reducing the breakage of specimens.

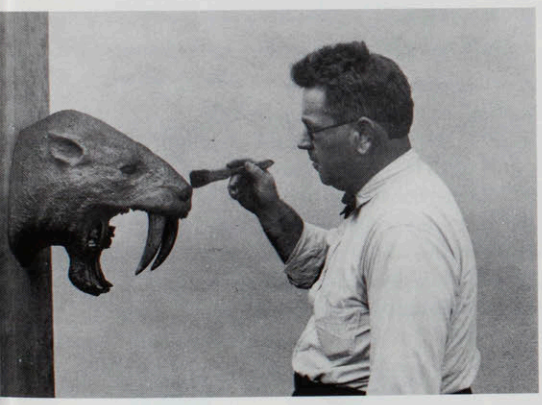
After the excavations were completed, Lytle supervised the sorting and cataloguing of the fossil collection. Although he had little formal education, he was a voracious reader, and studied geology, paleontology and comparative anatomy extensively to better understand the enormous task of identifying the bones from Rancho La Brea. Every one of the more than 750,000 specimens in the collection passed through Lytle's hands, was examined and identified, and then placed in appropriate storage.

Even with no formal training in art, Lytle sculpted several accurate reconstructions of late Pleistocene animals for exhibit at the museum. He also created many of the skeletal mounts that were displayed in Los Angeles and in other museums throughout the world.



RLB 1824

Lytle painting a cast of Merriam's Teratorn, April 14, 1923.



RLB 2376

Lytle putting the finishing touches to a restoration of *Smilodon fatalis* in October 1926.

RLB 1424

Lytle sorting Rancho La Brea fossils in the "bone room" in the basement of the Museum of History, Science and Art in 1921.

Roy Lee Moodie 1880-1934

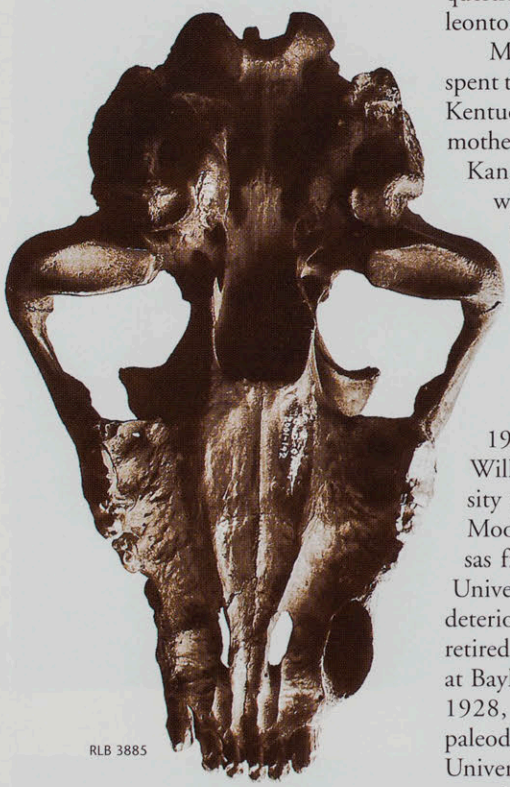
by Cathy McNassor

ROY L. MOODIE IS REMEMBERED FOR HIS PIONEERING studies of paleopathology, a discipline that he virtually created. Moodie examined the effects of disease upon ancient populations, both human and animal, and his extensive and detailed studies initiated a whole new field of investigation. In light of subsequent research, some of Moodie's diagnoses and conclusions have been questioned, but his cumulative contribution to paleontology was enormous.

Moodie, the fourth in a family of six children, spent the first ten years of his life in Bowling Green, Kentucky. In 1890, at the insistence of Moodie's mother, Sarah, the family moved to Sumner County, Kansas. She apparently felt that prohibition, which was being tried out in Kansas, would provide a better environment for her children. Though this move created much financial hardship, the Moodies managed to provide their children with a sound elementary education, and to send three of their sons through the University of Kansas.

Roy Moodie obtained his B.A. degree in 1905 under the guidance of Professor S. W. Williston. He followed Williston to the University of Chicago, and earned his Ph.D. in 1908. Moodie taught zoology at the University of Kansas from 1908 to 1913, and anatomy at Baylor University, Texas, from 1913 to 1924. Because of deteriorating health due to Parkinson's disease, he retired from active teaching in 1924. He continued at Baylor in the capacity of research librarian until 1928, when he moved to California to teach paleodontology at the College of Dentistry of the University of California for two years. In 1930, an appointment as a Research Associate of the Wellcome Research Institution allowed him the financial independence to continue his studies of paleopathology. Moodie died suddenly at age 54, after an accidental fall on his patio that resulted in a severely fractured femur and fatal hemorrhaging.

From 1923 until his death in 1934, Moodie devoted much effort to the examination of pathological specimens found at Rancho La Brea. In addition to many articles on these collections, a few days prior to his death, he completed a major manuscript entitled "Paleopathology of the California Saber-tooth and other Felidae." This work remained unpublished but is available from the archives of the Wellcome Foundation in Great Britain.



RLB 3885

In 1929, Moodie described this sabertoothed cat skull, which shows facial asymmetry due to the loss of the left canine. After the canine had been fractured and lost, its alveolus was resorbed. The only traces remaining of the left canine are fragments that were left protruding into the nasal cavity.

Courtesy of University of Kansas Archive

Fused series of II-V lumbar vertebrae of a sabertoothed cat, *Smilodon fatalis,* that Moodie described in 1927. The centra of lumbar vertebrae II through IV were fused together by smooth bone, and there is a massive bony growth across the neural arches on the right sides of lumbars III through V. This debilitating trauma was probably caused by compression and severe twisting of the lower back that seriously affected both bony and soft tissues.

RLB A-126 B

Hildegarde Howard 1901-1998

by Cathy McNassor

Hildegarde Howard began her long association with the Los Angeles County Museum of History, Science and Art in 1921, while she was an undergraduate student at the Southern Branch of the University of California, Los Angeles. Her first assignment for the museum was to identify sabertoothed cat vertebrae from Rancho La Brea for museum osteologist J. W. Lytle to use in a skeletal mount. She went on to attain international recognition in the field of avian paleontology, and some of her most significant research was done on the bird fossils from Rancho La Brea. In 1951, she was appointed to the position of Chief Curator of Science at the museum.

Howard had no intention of becoming a scientist, but was inspired by her first biology professor, Miss Pirie Davidson, herself a former student of Chester Stock. Davidson arranged for Howard's first position at the museum. In 1922, Howard went to the University of California, Berkeley, to finish her bachelor's degree because UCLA was a two year school at that time. At Berkeley she studied under Stock, and completed her degree in 1924. She returned to Los Angeles, where she worked part time for Loye Miller at UCLA, and part time at the museum. Miller guided her towards the field of avian paleontology, and in 1925 she returned to Berkeley, where she obtained her Master's Degree in 1926, writing a thesis on the California Turkey from Rancho La Brea. She continued her studies at Berkeley and, in 1928, received her Ph.D. with a dissertation on "The Avifauna of Emeryville Shellmound," a work that is still considered a landmark publication in the field of avian paleontology.

Shortly thereafter, Howard was offered a full-time position at the Los Angeles County Museum of History, Science and Art. As a "day laborer," her job consisted of curating the thousands of bird fossils from Rancho La Brea. After a heavy rain storm flooded the museum basement, soaking the Rancho La Brea mammal collection, Lytle assigned Hildegarde to work with Henry Wylde cleaning up the damage. This temporary assignment led to their marriage in 1930, a union that lasted 54 years.

Though closely associated with Rancho La Brea throughout her long career, Howard's contribution to avian paleontology extends to many other sites as well and includes 140 publications. In 1953, Hildegarde Howard was the first woman to be awarded the American Ornithologists Union's prestigious Brewster Medal for her outstanding research in the field of avian paleontology, and particularly for her work with the fossil birds of Rancho La Brea. Although she retired in 1961, she continued to undertake research at the museum until 1990. In 1991 she donated her original notes and manuscripts on Rancho La Brea topics to the Page Museum.

Natural History Museum Archive S_63.101

Howard in 1963 continuing her research after her retirement.

Natural History Museum Archive

A young Hildegarde Howard measuring bird fossils in 1938.

Natural History Museum Archive

Howard in 1961 receiving a county scroll from Supervisor Ernest E. Debs to mark her retirement from Chief of the Sciences Division.

The Geologic Setting of Rancho La Brea

by James P. Quinn

The Earth's 4.5-billion-year history is depicted on the time ribbon mural in the Page Museum. Each inch of the 83-foot-long ribbon represents about five million years. The fossils of the vertebrate species from Rancho La Brea were formed from 9,000 to 40,000 years ago, and have been used to define an interval of time—the Rancholabrean Land Mammal Age— that represents the last 500,000 years of the Pleistocene Epoch (see geologic time scale, below). The 31,000-year interval in which the fossils themselves appear is 1/100th of an inch (thinner than a sheet of paper) from the end of the ribbon. If the Earth's history were reduced to a 24-hour day, the first victims of the Rancho La Brea asphalt would have been trapped 3/4 of a second before the end of the day.

THERE ARE TWO REASONS WHY ANIMAL AND plant remains were preserved in the vicinity of Hancock Park: the asphalt seeps and the stream deposits that covered them. The asphalt seeps originated from organic-rich sediments that accumulated in the Pacific Ocean during the Tertiary Period. The stream deposits were laid down towards the end of the Pleistocene Epoch after sea level had fallen. Both events are related to crustal movement between the North American tectonic plate and oceanic plates of the Pacific—also the source of the earthquakes for which California is notorious.

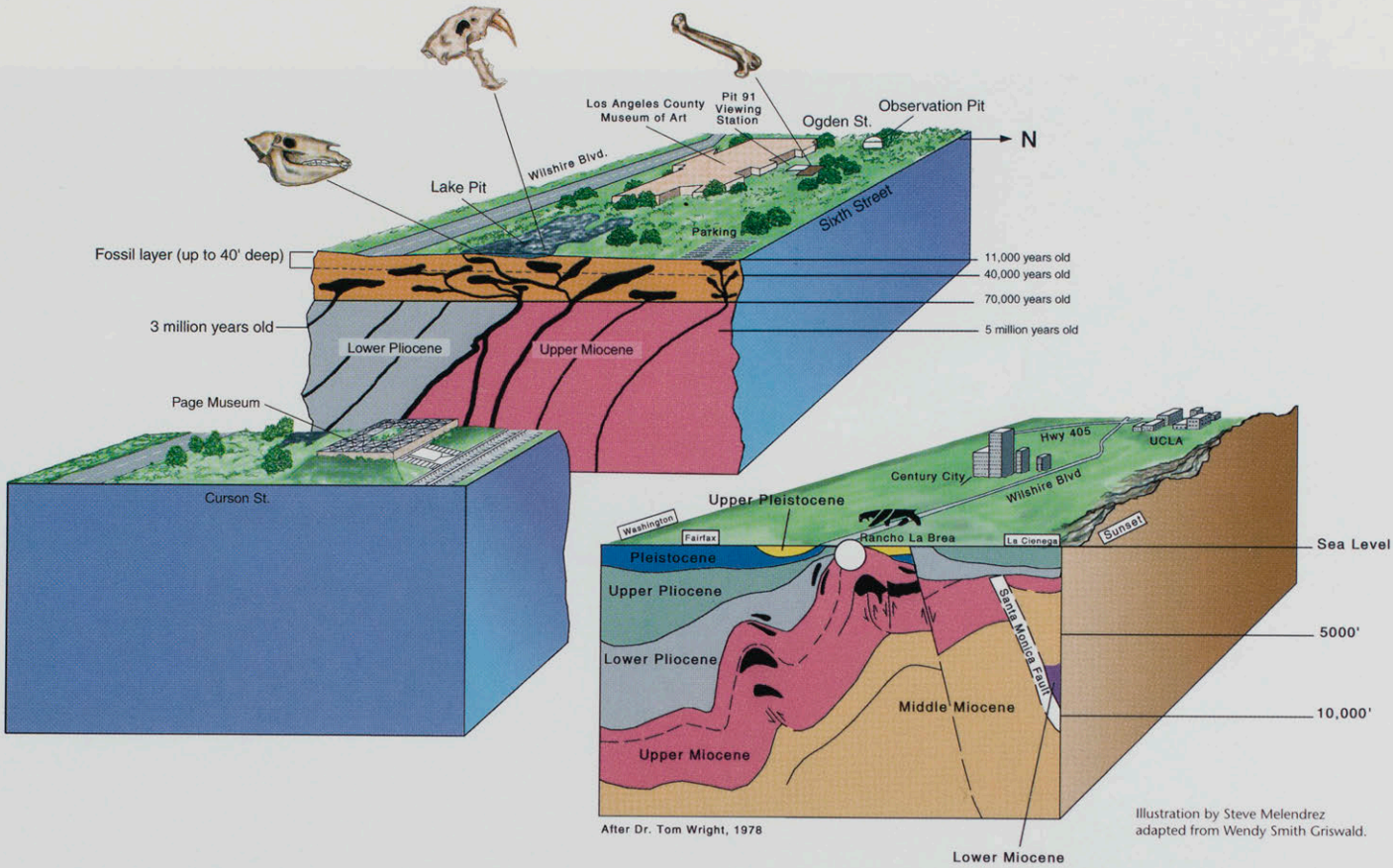
GEOLOGIC HISTORY OF THE LOS ANGELES BASIN

Rancho La Brea is sited in the northern part of the Los Angeles basin, which is part of a larger, deep structural depression created by movement between the Pacific and North American plates during the later part of the Miocene Epoch. Geological evidence suggests that the Los Angeles structural basin is only the latest of several depositional basins formed in this region by crustal movement.

Much of what is now southern California formed part of the ocean floor during the Mesozoic Era (the "Age of Dinosaurs"), but during the later part of the Cretaceous Period (about 100 million years ago), regional uplift and erosion occurred along the western margin of North America. Sequences of continental and marine sediments were subsequently laid down along the edges of the continent during the late Cretaceous and early part of the Tertiary Periods. In the Los Angeles area, the North American plate impinged upon the Pacific plate about 17 to 18 million years ago, during the early Miocene. Much of the Los Angeles region was above sea level at this time.

Era	Period	Epoch	Millions of Years Ago
Cenozoic	Quaternary	Holocene	0.01
		Pleistocene	1.8
	Tertiary	Pliocene	5
		Miocene	24
		Oligocene	38
		Eocene	54
		Paleocene	65
Mesozoic	Cretaceous		145
	Jurassic		210
	Triassic		250
Paleozoic	Permian		290
	Carboniferous		365
	Devonian		415
	Silurian		465
	Ordovician		510
	Cambrian		575

Jerome and Elma Connolly 1976



A hypothetical slice through the ground beneath Rancho La Brea (bottom box) shows that the asphalt seeping on to the surface in Hancock Park today has migrated upwards from reservoirs of petroleum contained in folded rocks of Miocene and Pliocene age. The petroleum originated from organically rich sediments that accumulated when what is now the Los Angeles basin lay beneath the Pacific Ocean. The fossils from Rancho La Brea, some of which are at least 36,000 years old, occur at depths of up to forty feet below the present ground surface (top box).

An extensive basin began to form in the Los Angeles region during the middle part of the Miocene Epoch as the Pacific plate moved northward relative to the North American plate. A thick sequence of gravel, sand, and fine-grained marine sediments began to accumulate on the slopes and floor of this developing basin. Although the basin continued to subside, it remained separated from the open ocean by a submerged ridge. As a result, the water in the deeper central part of the basin became stagnant. Organically rich sediments accumulating in such stagnant waters were to become an important regional source of petroleum. Major submarine canyons emanating from the north and east built fan-shaped deposits into the deeper water portions of the basin, diluting and then covering the organic sediments. In the later part of the middle Miocene, this extensive basin began to deform, subdividing into smaller Los Angeles, San Fernando and San Gabriel basins.

The newly formed Los Angeles basin initially became deeper during the late Miocene and early Pliocene, but gradually became filled as deposition continued into the Pleistocene. The Santa Monica fault system became active during the late Miocene, resulting in uplift of the Santa Monica mountains. These have been emergent since the early Pliocene (five million years ago), but were of lower elevation until the Pleistocene (two million years ago). The Los Angeles basin continued to subside and developed deepening marine conditions into the Pliocene, but was gradually filled with sediments by the late Pleistocene.

Although the Pleistocene continental ice sheets did not impact Los Angeles directly, alternating glacial and interglacial conditions resulted in oscillations of sea level that in turn affected the location of the Pacific shore line within the basin. Clastic sediments from the rapidly rising local mountains formed alluvial plains that pushed the oscillating shoreline to the west and south until it reached its present location.

GEOLOGIC HISTORY OF RANCHO LA BREA

In the vicinity of Hancock Park, Pleistocene shallow marine sediments, sometimes called the San Pedro Sand, rest upon inclined older marine Pliocene strata. The San Pedro Sand was tilted and then overlain by late Pleistocene shallow marine and terrestrial deposits. The tilting may have coincided with a fall in sea level during the Illinoian Glacial Stage. Marine conditions persisted in the area of Hancock Park until at least 100,000 years ago, according to interpretation of fossils collected 50 to 75 feet below the present ground surface at a building site next to the park.

A combination of crustal uplift, fall in sea level, and stream deposits filled in the shallow marine embayment that had been present in the Hancock Park area during the Wisconsinan Glacial Stage (20,000 years ago). Detritus eroded from the Santa Monica mountains was deposited on what is now called the Santa Monica plain by streams that drained southeastward across the area of Rancho La Brea during the last Ice Age. It is within the 40- to 50-foot-thick remnant veneer of Wisconsinan alluvial sediments at Hancock Park that the abundant remains of fossils occur. During the latest Pleistocene to the Holocene, drainage shifted to the southwest as the result of relatively rapid uplift of the La Brea Plain, Elysian Hills, and Baldwin Hills. Erosion of the late Pleistocene sediments across the La Brea Plain exposed fossil-bearing asphaltic sediments, contributing to the discoveries at Hancock Park.

ORIGIN OF THE ASPHALT

The extraordinary abundance of fossils at Rancho La Brea is in large part due to the presence of asphalt seeps. As noted above, vast quantities of organic matter, what is technically known as sapropel-rich kerogen, were preserved in the thick pile of Miocene and Pliocene marine sediments deposited under oxygen-deficient conditions in the Los Angeles basin. These were buried beneath a great thickness of younger sediments. With increasing depth of burial, the organically rich deposits were subjected to increasing temperature, converting some of the organic matter to oil. Compressed by the weight of overlying deposits, the oil was "squeezed out" of the organic matter into pore spaces in the surrounding rocks. Exuded oil migrated to more permeable zones and ultimately collected in structural and stratigraphic traps created by earth movements during the late Pliocene and Quaternary. As a result, many oil reservoirs were formed along the deforming margins of the basin. Hancock Park is situated between the Salt Lake and South Salt Lake oil fields.

Surface asphalt seeps and fossil sites in the vicinity of Hancock Park exhibit a strong northwest-southeast trend. This has been explained in two ways: (a) upward migration of oil along the Sixth Street fault—a possible extension of the Las Cienegas fault; (b) seepage from steeply dipping, truncated Tertiary oil sands below the Pleistocene deposits. As liquid and gaseous hydrocarbons migrate upward through the overlying deposits, they are subjected to biodegradation and oxidation. Driven by buoyancy, the asphalt (which is viscous oil that has been depleted of most of its volatile components) oozes onto the surface through vents or fissures. On nearly horizontal surfaces, thin and nearly flat asphalt deposits develop around active vents. On inclines, the discharged asphalt flows and may produce extensive sheet-like deposits. Local ponding occurs in depressions, but deep, extensive natural pools of liquid asphalt—the popular but inaccurate conception of the "tar pits"—have not been observed. The asphalt often impregnates permeable materials next to vents or surface flows.

Observed rates of asphalt extrusion vary considerably. Some vents or fissures appear to be continuously active, but the amount of discharge is not uniform. Others are only intermittently active, perhaps producing copious amounts for several weeks or months, then becoming dormant. Radiometric dating reveals that asphalt discharge from single loci has persisted for thousands of years.

The viscosity of surface asphalt varies with the temperature. During the warmer months of late spring, summer, and early fall, discharged asphalt is more fluid, tends to flow a greater distance, and more easily impregnates the porous sediments on which it flows. Fallen leaves and windblown debris readily stick to the surface, and small animals that come in contact with the viscid liquid may become mired. Asphalt-impregnated sands exposed at the surface during the warmest time of year yield easily to pressure, and have the potential to entrap large animals. In the cooler months of fall, winter and spring, the reverse is true: asphalt flows neither as quickly nor as far; surface sheets typically congeal and are much less sticky so that entrapment of large and small animals or debris is unlikely. Diurnal changes in temperature similarly affect asphalt viscosity. Asphalt exposed at the surface oxidizes with time to form hard, resistant deposits of asphaltite.

Local ponding occurs in depressions, but deep, extensive natural pools of liquid asphalt—the popular but inaccurate conception of the "tar pits"—have not been observed.

Rainfall in the Los Angeles Basin during the Wisconsinan was apparently greater than at present, occurring in the cooler months of fall and winter. Sediment from the Santa Monica mountains was carried by flood waters to be deposited as alluvium. In the area of Hancock Park, the congealed or oxidized asphalt and asphalt-impregnated sediments were covered by such alluvium. During subsequent warm weather, active seeps penetrated the ground surface and new asphaltic deposits developed. In this way, stream sediments, asphaltic concentrations of fossils, and asphaltite lenses developed and became mixed together through time.

James Quinn is a registered geologist and a research associate of the Rancho La Brea Department at the Page Museum.

Entrapment Events

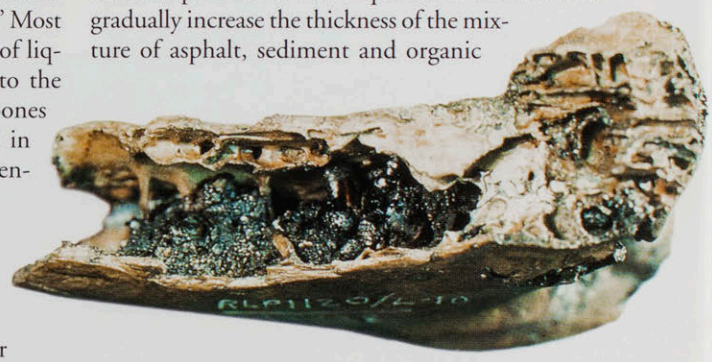
by Christopher A. Shaw and James P. Quinn

TANGLED MASSES OF DENSELY CONCENTRATED bones are characteristic of the Rancho La Brea deposits but are not easily explained. They often occur either in the form of deep asphaltic lenses or narrow cylindrical "pipes" that extend upwards or sideways through surrounding layers of soil and sediment. How the bones got there in the first place, why they are all jumbled together, and what caused bones from individual skeletons to become so widely scattered are questions that have confronted paleontologists for decades. We still don't have all the answers, but we no longer believe that the animals were trapped in "deep pools of tar." Most appear to have been captured in thin sheets of liquid asphalt similar to those still oozing onto the surface of the ground today. Some of the bones and plant remains had already been buried in stream channel deposits before the asphalt penetrated those sediments.

Asphalt is very sticky, particularly when warm. Small mammals, birds, and insects inadvertently coming into contact with it would be immobilized as if they were trapped by flypaper. The feet and legs of heavier animals that were unaware of the danger—particularly if the surface of the seep was camouflaged by dirt and leaves—might sink two or three inches below its surface. Depending on the time of day and of year, strong and healthy animals may have managed to extricate themselves but others would have been held fast until they died of exhaustion, or fell prey to passing predators.

Once stuck in the asphalt, the lower limbs and pelvis were more likely to be preserved than other parts of the body—which might be carried away by scavengers or subjected to weathering by the elements. Heavily weathered bones, fossilized fly pupae, and the remains of other insects suggest that some carcasses were exposed above the surface of the seep for weeks or even months. The odor of rotting flesh would have added a piquant counterpoint to the effluvia of methane gas and other hydrocarbons!

Fossilization was not assured until the remains of animals trapped by the asphalt were buried by stream-borne sand and silt during ensuing winter rains. Repetition of this sequence of events would gradually increase the thickness of the mixture of asphalt, sediment and organic remains. Depending on the location and size of individual seeps, the periodic cycle of warm weather entrapment and cool season burial would after many years result in a variety of differently-shaped fossil-bearing asphaltic masses—future treasure troves for paleontologists.



RLB 1898C

Fossilized blowfly larvae preserved in a teratorn ulna (the larger of the two bones of the lower arm).

The tight packing and chaotic arrangement of individual bones within such masses might have been produced by trampling. In their frantic efforts to escape an awful fate, newly trapped animals would have trodden on the remains of previous victims, pushing them deeper into the seep and enhancing their chances of preservation. Trampling may also have accounted for some instances of "pit wear"—unusual grooves and wear surfaces produced by one bone abrading against others.

One explanation of the unusually high ratio of large carnivorous mammals and birds in the assemblages from Rancho La Brea and other asphaltic deposits is that these were trapped in the asphalt while attempting to feed from previous victims of the seeps. One bogged herbivore may have attracted several carnivores and scavengers that were in turn entrapped. Given that the extinct elements in the Rancho La Brea biota represent an interval of 25,000 years, an episode in which one large herbivore lured four dire wolves, a sabertooth and a coyote to a sticky end would only need to have occurred once every decade in order to account for the number and proportions of the commonest fossils recovered from this locality.

An owl and its intended prey are victims of a shallow, present-day asphalt seep in Kern County, California.

Leslie F. Marcus

How the Fossils Were Preserved

by Christopher A. Shaw

RLB 4849

The parallel grooves on the *Smilodon* upper arm bone were caused by abrasion against other bones in the deposit and are an example of pit wear. Movement of one bone that is pressed against others in tightly packed bone accumulations also produces holes and worn surfaces. The cause of such movement is still a matter of debate, but could have been induced by the weight of animals trampling over the hardened surface of the asphaltic deposit or by earthquakes.

FOSSILS ARE REMAINS OR TRACES OF ANIMAL AND plant life that have been preserved through natural processes. The most frequent kind of fossilization is petrifaction (or petrification), in which the original organic material is replaced by silica or other mineral deposits, "turning it to stone." However, fossilization also occurs where there is little or no replacement or alteration of the original organic remains. Preservation of this kind can occur in caves (by incrustation of calcium carbonate or by mummification), peat bogs, amber, ice, and asphalt.

The excellent preservation of most fossils at Rancho La Brea is due to their impregnation by asphalt, which also stains the specimens various shades of brown and black. Asphalt is immiscible in water and protects the organic compounds in the fossils that might otherwise be leached out and carried away by ground water or replaced during petrifaction. Bones, exoskeletons of arthropods, and many parts of plants that were not subjected to extreme surface weathering remain virtually unaltered chemically or physically. As a result, the most delicate surface and internal structures of the fossils have survived for tens of thousands of years. Remains rarely found at other fossil sites are commonly preserved, including injured and diseased bones, auditory ossicles of mammals, thin-walled bones of birds, the fleshy parts of leaves, and the iridescent coloration in beetle wing covers. Fossil wood from Rancho La Brea appears fresh when broken and will readily burn. Bone collagen is preserved well enough to study the microstructure of the protein, and this protein has been used to date the deposits radiometrically and to demonstrate that normal body temperatures of the extinct Rancho La Brea mammals were similar to their closest living relatives.

On the other hand, some fossils were affected by processes that took place after the death of the organism. The outer layer of compact bone usually has a smooth texture; however, some bones are similar in appearance to modern ones that have lain on the ground for some time, and indicate that similar weathering occurred before these objects were preserved by asphalt. Other skeletal elements exhibit surface markings and breaks caused by the scavenging activities of carnivores and rodents. After burial, movement of large bones within the asphalt deposits is thought to be responsible for damage called "pit wear." Cuts or grooves into the bone may be deep and in some cases have nearly severed a specimen into two pieces. The outer surface of some bones may be entirely destroyed by this phenomenon; this has occurred on parts of the skull of La Brea Woman.

Not to be confused with pit wear are many examples of abrasion caused by water transport downstream, which abraded the edges of bones that are normally sharp or pointed. Concentrations of wood and bone have been found in channel lag deposits; in these instances, the asphalt preservative saturated the transported bones after they were deposited by the stream.

Flesh, keratin (which comprises hair, horn sheaths, claws, etc.), feathers, scales, and other soft organic tissues have not been found at Rancho La Brea. Many types of bacteria that live in the asphalt consume these soft tissues, and liquid asphalt, an organic solvent, may even dissolve them.

RLB 337

This 1915 photograph taken in Pit 77 shows a mass of bones concentrated in a vertical asphalt "pipe."

George C. Page, 1901-2000

by John M. Harris and Cathy McNassor

George C. Page was born on June 25, 1901, in the little rural town of Fremont, Nebraska. Through hard work and natural ability he became an astute businessman and a marketing genius, making his first fortune when he was barely out of his teens. Mr. Page was also a generous philanthropist, especially towards institutions that benefited children. He passed away on November 29, 2000, just seven months shy of his hundredth birthday.

Natural History Museum Archives

George Page, age 17, shortly after he arrived in Los Angeles.

George and Juliette Page at the Wawona Tree in Yosemite National Park, c. 1935.

As a 12-year-old schoolboy, Page had been given his first California orange by his favorite teacher. The fruit made such an impression on him that, when he left home at the age of 16, he made his way to California to seek his fortune. He figured that any place that could produce something like that orange might be pretty interesting. Hitchhiking to Los Angeles, he arrived with $2.30 in his pocket but by the end of a year—by dint of working two jobs and dining frugally on 10¢ bowls of soup (with free crackers and ketchup)—he had saved $1000. That Christmas he decided to send his mother a very special present from his new home, so he wrapped up a basket of all the various kinds of fruit grown in California and shipped it back to his family in Nebraska. He decorated the basket and made it so attractive that other residents of his boarding house were impressed and offered to pay him for similar packages to send to their relatives. Page immediately realized he was onto something and the following year created his thriving Mission Pak business that shipped gift packages of California fruit all over the country. He soon had 100 stores and over 1,000 employees making and selling fruit baskets.

Although Mission Pak was very profitable, the work was seasonal with the stores only opening during the Christmas season. This left Page the remainder of the year to travel and initiate other enterprises. The latter included making automobile bodies and real estate investments. On one of his visits to Paris, he had the opportunity to purchase the North American distribution rights for cellophane, but he declined the offer and later regretted this as one of his biggest business mistakes. In 1931 Page met and subsequently married Juliette Creste, his wife for 36 years.

At the beginning of World War II, Page converted his packing plant to a dehydration factory to manufacture dehydrated vegetables, mainly carrots, for the armed forces. After the war, he sold Mission Pak and then developed the first industrial parks in southern California, leasing to leading aircraft and electronics firms. Though initially his idea was received with great skepticism, his venture proved a spectacular success and Page became wealthy beyond his wildest dreams. Shortly thereafter, he decided that he had become wealthy enough and terminated his industrial business to devote the remainder of his life to philanthropy.

Soon after Page had arrived in Los Angeles in 1917, he learned about a place called "the tar pits," where fabulous fossils had been found. He took a street car to the location of the tar pits on Wilshire Boulevard but was greatly disappointed to find that all the fossils had been removed and stored at the Museum of History, Science and Art eight miles away in Exposition Park. As he wrote in his autobiography, *In My Own Words*, he thought, "What a wonderful attraction it would be if the ancient finds

Seaver Center Archive

Seaver Center Archive 7772A

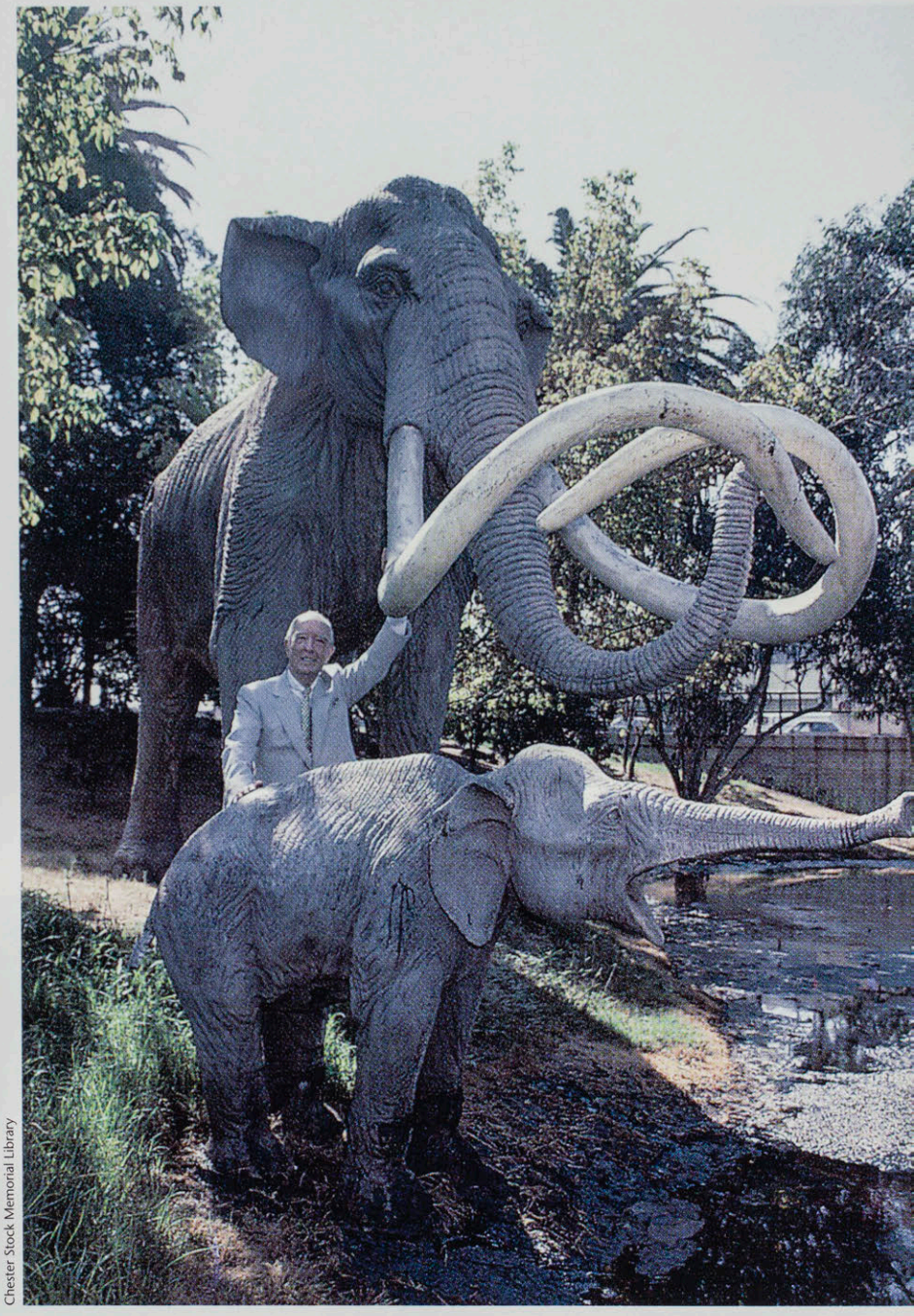
Natural History Museum Archive

Supervisor Ed Edelman, Mr. Page, and Supervisor Kenneth Hahn at the opening ceremony for the Page Museum.

Larry Reynolds 2114C

Since its opening in 1977, the Page Museum has been visited by many celebrities. Here, Mr. Page and Supervisor Kenneth Hahn present a scroll to Prince Charles in December 1977.

< Juliette Page, Mr. Page's wife, poses with an elaborate Mission Pak basket around 1940. Mission Pak was the first company founded by George Page; in 1918 he began shipping his baskets, decorated with colored paper and tinsel and filled with exotic California fruit, to customers all over the world. Mission Pak's first office was a rented storefront on Hill Street, but the company quickly grew to a multimillion dollar business with over 100 retail stores.



Chester Stock Memorial Library

George Page poses with reconstructions of the Columbian mammoths located on the bank of the Lake Pit.

Natural History Museum Archive

Mr. Page discusses the sabertoothed cat family restoration with young visitors to the museum.

could be exhibited in a facility on the site where they were discovered. That was my dream!" Half a century later, he was in a position to do something about it and approached the board of the Natural History Museum with an offer to build a museum at the tar pits as a gift to the people of Los Angeles. This offer was enthusiastically endorsed by the board of the museum and by the Board of Supervisors. Page hired Willis E. Fagan and Franklin W. Thornton to design an innovative building that would blend with the greenspace of Hancock Park. Ground-breaking began in early June 1975 but almost immediately construction was halted by the discovery of an extensive fossil deposit. Ironically, this was the only one of more than fifty fossil sites in Hancock Park that has yielded semi-articulated skeletons.

The completed museum opened in July 1977 as a testament to Page's aesthetic sense and design skills. The Page Museum of La Brea Discoveries was revolutionary in its presentation of exhibits, including more than thirty internally mounted skeletons (a technique pioneered by Natural History Museum preparators). Visitors came in droves to learn what life was like in Los Angeles during the waning phases of the last Ice Age. The "fishbowl lab" where visitors could watch staff and volunteers process fossils from the asphaltic deposits was an instant hit and was subsequently copied by museums around the world. Page was justifiably proud of his museum and continued to fine-tune the displays and setting for the next twenty years. He personally took care of the plants in the atrium, installed animatronic restorations of extinct animals for the younger visitors, and even at the age of 95 directed a film to explain why dinosaurs weren't found in the tar pits.

The Page Museum of La Brea Discoveries was only one of Page's philanthropic projects. He funded the George C. Page Building at Children's Hospital, the George C. Page Youth Center in Hawthorne, the George C. Page Stadium at Loyola Marymount University, several buildings at Pepperdine University—including two residence halls and a conference room—and programs at the USC School of Fine Arts. He also assisted many individuals, especially students. However, it was the museum—which opened on April 15, 1977—that captured Page's passion and became his permanent monument. In his autobiography he wrote:

> The hundreds of letters I've received from school children are a great source of joy to me, because they assure me that the museum has lived up to my fondest hopes. It is giving pleasure to both young and old, and has proven to be one of the

Chester Stock Memorial Library

The main entrance to the George C. Page Museum of La Brea Discoveries shortly after it was opened to the public on June 15, 1977.

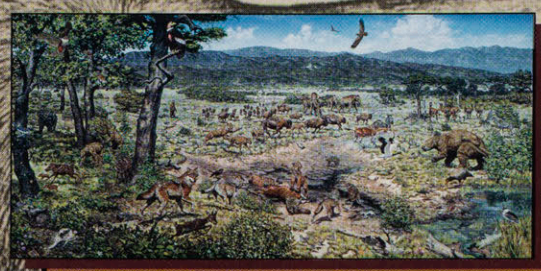
most rewarding of my philanthropic projects. Every time I see school buses lining the block by the museum, bringing school children from far and near, I get a deep feeling of satisfaction and I know my time and efforts were justified."

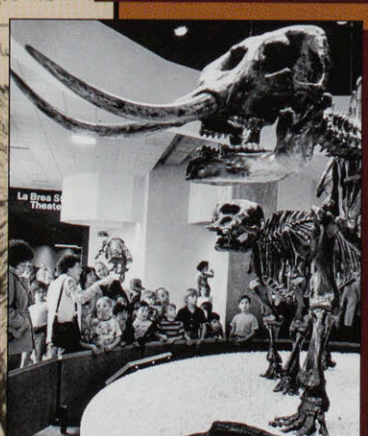
Mr. Page was a remarkable man who left a remarkable and enduring monument—The George C. Page Museum of La Brea Discoveries—for the children of Los Angeles, for the people of America, and for the international scientific community. On December 4, 2000, he was laid to rest at a beautiful location overlooking the ocean in the Santa Barbara Cemetery, next to his beloved wife Juliette, and close to the family home of his adopted son.

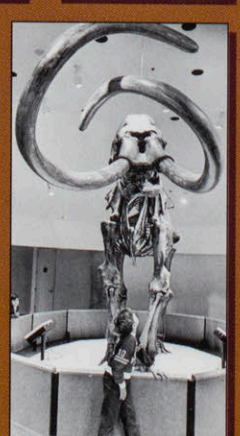
Courtesy Fong and Asociates

Map of Hancock park after its renovation in 1997–98.

Timetable of Events at La Brea Tar Pits:







40,000–12,000 BP
Late Pleistocene animals trapped by asphalt

9,000 BP
First evidence of human habitation in Los Angeles

1769
"Swamps of bitumen" documented by de Portola Expedition

1875
First documentation of fossils from the asphalt deposits

1909
Excavation by Southern California Academy of Sciences

1913–1915
Excavations by Museum of History, Science and Art

1924
Hancock Park donated to the County of Los Angeles

1929
Further excavations by Museum of History, Science and Art

1934–1938
Cast stone statues installed in park.

1940
La Brea Tar Pits designated California State Historic Landmark No. 170

1952
Observation Pit opened

1963
Rancho La Brea designated a National Natural Landmark

1968
Fiberglass statues installed at Lake Pit

1969
Pit 91 excavation began

1974
Smilodon fatalis designated the California State Fossil

1975
Page Museum construction began

1977
Page Museum opened

MEMBERSHIP ANNOUNCEMENT:

A Wonderful World is Yours to Give!

Surprise someone special with a Natural History Museum membership, which includes the Page Museum at the La Brea Tar Pits and the William S. Hart Museum.

Among the many benefits that your gift includes are unlimited free admission to these three great museums; *TERRA* and the *Naturalist,* the museum's publications; invitations to members-only events; discounts on museum educational programs and at museum shops; and exciting travel opportunities. A beautiful card and a gift membership packet will be sent to announce your gift.

Don't miss this opportunity to purchase a gift that will bring a full year of pleasure. Please call the Membership Services office at 213/763-3426.

CORPORATE INVOLVEMENT:

The Natural History Museum's Corporate Relations program was established on September 1, 2000 to foster long-term, strategic corporate partnerships in support of the museum's ongoing operations and the campaign for the new museum. Opportunities for partnership include:

The Corporate Partners Membership Program

The Corporate Partners Membership Program supports the Natural History Museum through annual, unrestricted donations. Corporate Partners can receive many exciting benefits, including invitations to preview major exhibits at VIP receptions; family day at the museum for your employees; private behind-the-scenes tours with museum curators; invitations to participate in our Executive Breakfast Series; and access to museum curators while on major research expeditions. Contact Corporate Partners Officer at 213/763-3355 or via email at corporatepartners@nhm.org.

Corporate Sponsorship Program

Serving as an educational resource for more than 760,000 families annually, the museum is the perfect environment to create powerful and memorable exposure for your company. Whether your company seeks community presence or national brand visibility, partnerships are available for our local or national touring exhibits, children's educational programs and field expeditions. Sponsorship is an investment in science education, cultural understanding and world-class research.

Depending on your company's marketing priorities and community relations needs, we can create a custom program designed to meet your goals. For more information about sponsorship opportunities, please contact the Director of Corporate Relations at 213/763-3315 or via email at sponsorship@nhm.org.

THE PAGE MUSEUM:

The George C. Page Museum of La Brea Discoveries in Hancock Park is located at the site of one of the world's richest deposits of Ice Age fossils. Its galleries, laboratories, and storerooms house the Rancho La Brea heritage—more than three million fossil plants and animals that have been excavated from the La Brea Tar Pits since the early 1900s. This vast collection, which is the basis for the museum's rich displays of extinct creatures and prehistoric landscapes, gives an incredibly detailed picture of life in North America from 4,000 to 40,000 years ago.

For information on the Page Museum, please call 323/934-PAGE or visit the web site at www.tarpits.org.

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OF LOS ANGELES COUNTY

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